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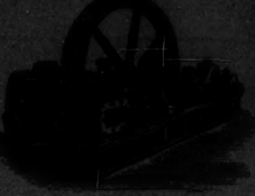

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XIV.—No. 327.

TELEGRAPHIC APPARATUS.

A GLANCE through the list of patents taken out within the last few years shows that but very little interest is taken in telegraphic apparatus generally. This, no doubt, is chiefly due to the fact that the demand for new forms of instruments is but very slight, and that consequently there is practically no field for ingenuity in this direction.

In this country, owing to the fact that the telegraph system is in the hands of the State, there is an entire absence of competition, and consequently the stimulus which the latter affords is absent. In many respects telegraphy has reached a point of perfection which renders improvements extremely difficult to be effected by outsiders who do not know the actual requirements of the service. In order that an inventor may be able to grasp the numerous points of difficulty which are met with in carrying on telegraphic communication on a large scale, he requires an amount of information which can only properly be obtained by actual practice. Many inventors bring out very ingenious forms of apparatus for effecting a particular object, the only noticeable feature of the new invention being that it effects the object in a different manner to that in which it has hitherto been done. It is, as a rule, very difficult to convince such inventors that their ingenuity is greatly misplaced, and that they are not hardly treated because their notions are rejected.

Although for telegraph apparatus for overland purposes there is but little scope for invention, yet in the domain of submarine telegraphy there is a vast field for research, and that field is almost wholly unexplored. The speed with which long ocean cables can be worked at the present time is by no means high ; yet the limit appears to have been reached with the methods at present employed for working. If further progress is to be made, some entirely new departure would appear necessary. We believe that no branch of electrical science would prove so profitable to the successful inventor as that of fast speed working through long ocean cables, and it is somewhat surprising that so comparatively little has been done in the matter.

ON THE GALVANIC BEHAVIOUR OF THE AMALGAMS OF ZINC AND OF CADMIUM.

By W. L. ROBB.

(*Continued from page* 153.)

d. On the electromotive force of galvanic elements consisting of pure and amalgamated zinc in dilute acids.—I have examined the potential difference of pure and of amalgamated zinc in dilute sulphuric and acetic acids, which do not attack amalgamated zinc.

The electromotive force in this case did not become constant as occurred with zinc rods in solutions of salts of zinc, but increased first to a maximum and then progressively decreased.

Examples are given in the two following tables. Here *t* signifies the time which had elapsed since the zinc rods were placed in the acid, and, *e*, the potential in the amalgamated zinc, the potential of the non-amalgamated rod being, as before, taken as the null value (*see* fig. 1) :—

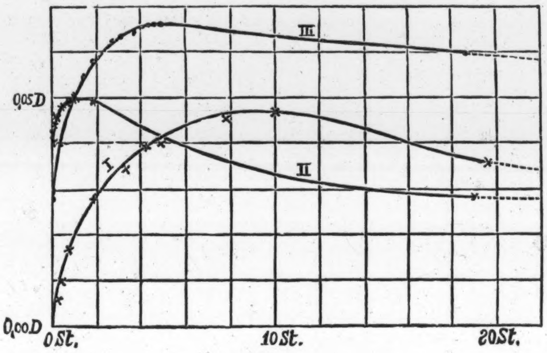

FIG. 1.

AMALGAMATED AND NON-AMALGAMATED ZINC IN DILUTE SULPHURIC ACID (ABOUT 3 PER CENT).

t.	*e.*	
About 9 min.	+ 0·006 D.	*See Curve I. fig.* 1.
„ 18 „	+ 0·010 „	
„ 40 „	+ 0·016 „	
1 hour 50 „	+ 0·0275 „	
3 hours 5 „	+ 0·0344 „	
4 „ 10 „	+ 0·0390 „	
4 „ 40 „	+ 0·0398 „	
7 „ 40 „	+ 0·0465 „	
10 „ — „	+ 0·0473 „	
19 „ 30 „	+ 0·0358 „	

AMALGAMATED AND NON-AMALGAMATED ZINC IN DILUTE ACETIC ACID (ABOUT 50 PER CENT.)

t.	*e.*	
About 5 min.	+ 0·0398 D.	*See Curve II., fig.* 1.
„ 8 „	+ 0·0430 „	
„ 13 „	+ 0·0457 „	
„ 15 „	+ 0·0469 „	
„ 36 „	+ 0·0489 „	
1 hour 2 „	+ 0·0502 „	
„ 48 „	+ 0·0490 „	
6 „ 15 „	+ 0·0382 „	
19 „ —	+ 0·0278 „	

In both cases the electromotive force continued to decline.

It is seen that in these experiments the amalgamated zinc is constantly positive to the unamalgamated.

To be sure that no change of importance had occurred in the electric constitution of the surfaces of the zinc rods whilst they remained in the acid, their electromotive force was determined in a solution of zinc sulphate, both before they were placed in the acid and after they were taken out.

During the entire time of their stay in the acid the non-amalgamated zincs were attacked by the acid, and thereby on the surface of the zinc the acid was replaced by a corresponding quantity of zinc oxide. Hence it might be conjectured that the electromotive force measured was chiefly occasioned by the formation of the salt of zinc, and instead of equalling the sum :

Zn | Hg Zn + Hg Zn | acid + acid | Zn, may really be equal to the sum—

Zn | Hg Zn + Hg Zn | acid + acid | zinc salt + zinc — salt | Zn.

The purpose of the next experiments was to obtain a decision on this conjecture. Elements consisting of two liquids, an acid and a solution of the corresponding salt of zinc were first examined. The concentration of the solutions of salts of zinc was the same which was obtained by dissolving zinc in acids of the strength employed. The sulphuric acid employed was very dilute (about 3 per cent.), but the acetic acid was moderately strong (about 50 per cent.) The two vessels, the one containing the acid and the other the corresponding salt of zinc, were connected by a syphon filled with the acid as the specifically lighter of the two liquids.

In the first place the electromotive force was measured while the amalgamated zinc was in the acid and the non-amalgamated in the corresponding solution of a salt of zinc. The electromotive force varied at first a little, but soon took a constant value, as when the zinc rods were immersed in a strong solution of a salt of zinc, and remained for several hours without any great decrease. When sulphuric acid and solution of zinc sulphate were employed the constant value of e, was equal to + 0·0591 D., and when acetic acid and zinc acetate were taken it was = + 0·0464 D. These values are approximately equal to the maximum values of e when the zinc rods were immersed in the acids.

The amalgamated and the non-amalgamated zinc were then transposed. The value of the electromotive force immediately on immersion was a little more than 0·01 D., and then continually approached to 0. The amalgamated zinc was negative to the non-amalgamated.

The last-mentioned experiments were also conducted in a modified form. The lower portion of a vessel was filled with the solution of the salt of zinc and the upper with the corresponding acid. The two liquids remained fairly distinct from each other in consequence of the difference in their specific gravity, diffusion was prevented by the use of a syphon, and the distinctness of the two was fairly preserved. This arrangement of the experiments gave similar results. When the amalgamated zinc was placed in sulphuric acid, and the non-amalgamated in the solution of zinc sulphate, e = + 0·0612 D., but if acetic acid and zinc acetate were used, e = + 0·0541 D. Also, when the zinc rods were transposed their behaviour was the same as in the former determinations with elements consisting of two liquids. The value of the electromotive force was also determined when both of the zinc rods were amalgamated, it never differed by more than a few thousandths of a Daniell from the values which were found when the amalgamated zinc was placed in the acid and the non-amalgamated in the solution of the corresponding salt of zinc. This difference may be explained by a very trifling alteration in the surfaces of the zinc rods. The zinc rod, which was immersed in the solution of the salt of zinc was negative to the other. As we see in all the above experiments the zinc rod which was placed in the salt solution was negative to that immersed in the acid, whichever of the two had been amalgamated.

All these determinations agree with the above conjecture as to the origin of the electromotive force when the pure and the amalgamated zinc were immersed in an acid. The maximum values which appeared when both zinc rods were placed in acids could not, on account of the unequal diffusion occurring in different cases, agree more closely with those observed when the amalgamated zinc was in an acid and the non-amalgamated in the corresponding solution of a salt of zinc. For the same reason the value of the electromotive force when the non-amalgamated zinc was placed in the acid, and the amalgamated in a solution of a salt of zinc could not be = 0.

In the above determinations of the electromotive force, when both zinc rods were placed in acids their position was vertical. The electromotive force was therefore next measured when both rods were placed horizontally, the one at the bottom of the vessel and the other near the surface of the liquid. When the non-amalgamated zinc rod was at the bottom, the value of the electromotive force increased to a certain limit. This value remained for a long time nearly constant, and then decreased slowly. The next following table gives an example. (See fig. 1.)

In dilute acetic acid, e = + 0·0674 D, after the constant value had been reached.

When the amalgamated zinc rod was placed lowest, the value of the electromotive force decreased continuously from that observed on the first immersion of the zinc rods in the liquid, and which amounted to a few hundredths of a Daniell. The amalgamated zinc was positive to the unamalgamated.

PURE AND AMALGAMATED ZINC IN DILUTE SULPHURIC ACID.

t.	*e.*
5 minutes	+ 0·0267 D
10 „	+ 0·0292 „
31 „	+ 0·0396 „
1 hour 3 „	+ 0·0495 „
1 „ 33 „	+ 0·0559 „
1 „ 50 „	+ 0·0586 „
2 „ 22 „	+ 0·0621 „
2 „ 59 „	+ 0·0637 „
3 „ 37 „	+ 0·0645 „
4 „ 3 „	+ 0·0657 „
4 „ 10 „	+ 0·0657 „
4 „ 20 „	+ 0·0658 „
4 „ 37 „	+ 0·0658 „
6 „ 7 „	+ 0·0651 „
18 „ 30 „	+ 0·0594 „

See Curve III., fig. 1.

These experiments also can be explained on the above-mentioned hypothesis. When the non-amalgamated zinc was lowest the acid in the lower part of the vessel was soon replaced by the solution of a salt of zinc, and as this is specifically heavier than the acid diffusion was slower than when the zinc rods were vertical. Hence the maximum value of e was more permanent.

An experiment was made with acetic acid in order to determine how long the decrease of the electromotive force continued. The zinc rods were placed vertically. The result is shown in the following table (see fig. 2) :—

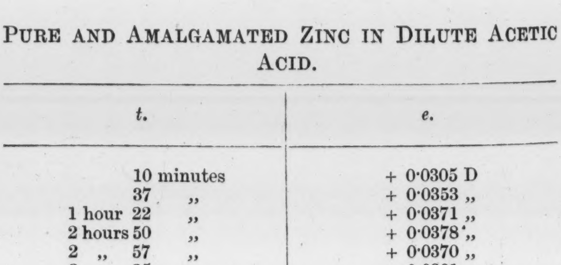

FIG. 2.

PURE AND AMALGAMATED ZINC IN DILUTE ACETIC ACID.

t.	*e.*
10 minutes	+ 0·0305 D
37 „	+ 0·0353 „
1 hour 22 „	+ 0·0371 „
2 hours 50 „	+ 0·0378 „
2 „ 57 „	+ 0·0370 „
8 „ 35 „	+ 0·0301 „
29 „ 40 „	+ 0·0205 „
45 „ 50 „	+ 0·0175 „
49 „ 35 „	+ 0·0159 „
57 „ — „	+ 0·0139 „
71 „ 30 „	+ 0·0123 „
76 „ 30 „	+ 0·0105 „
95 „ 20 „	+ 0·0099 „
121 „ 30 „	+ 0·0085 „

When the last determination was made the electromotive force had not entirely ceased decreasing, and in all probability this decline continues down to the value observed when the zinc rods were placed in a solution of zinc acetate.

From these experiments we are justified in concluding that amalgamated zinc in acids is positive to non-amalgamated zinc. The cause, however, does not lie in the difference of its electric nature, but is at least principally induced by transformation of the acids into salts of zinc on the surface of the rods.

3. *Experiments on the behaviour of Cadmium Amalgam.*

Since, according to earlier experiments, amalgamated cadmium is said to be negative to pure cadmium, I have also made some observations on the behaviour of the metal in both states in cadmium sulphate.

As in case of zinc, two pieces of the purest commercial cadmium, taken from the same ingot, were unlike in their galvanic behaviour, the difference being almost the same as with zinc. The cadmium rods were equalised by being coated with galvanically deposited cadmium. The cadmium, however, was simply precipitated upon rods of distilled cadmium. The several pieces of cadmium were equalised by this method as well as the zinc rods. On account of the observation made with zinc, I used in my first experiments for the determination of the electromotive force neutralised, solutions of cadmium sulphate. The electromotive force was determined both when both rods were unamalgamated and when one of them was amalgamated. All the precautions used in the case of zinc were applied here also. After the amalgamated and the pure cadmium had been placed in a concentrated solution of cadmium sulphate the electromotive force varied, as with zinc, for about an hour, sometimes increasing and sometimes decreasing. The electromotive force then became relatively constant, but then decreased slowly to a limit where it became quite constant.

The surface of the amalgamated cadmium was at first very brilliant, but gradually lost its lustre as the electromotive force declined. It seemed as if a solid compound of cadmium and mercury had been formed. Amalgamated zinc, on the contrary, always retains its mercury-like appearance. In the following table the values of e_2 are those found after the electromotive force had become relatively constant. e_1 and $e_2 - e_1$ have the same signification as in the corresponding experiments with zinc :—

CADMIUM IN A NEUTRALISED SOLUTION OF CADMIUM SULPHATE.

No.	e_1	e_2.	$e_2 - e_1$.
1	+ 0·0001 D	− 0·0433 D	− 0·0434 D
2	− 0·0003 „	− 0·0468 „	− 0·0465 „
3	+ 0·0001 „	− 0·0438 „	− 0·0439 „
		Mean Value ...	− 0·0446 D

These values of e_2 remained constant during about an hour, the variation amounting merely to 0·0001 — 0·0005 D. The electromotive force then declined with the loss of the lustre of the amalgamated metal, and after the rods had remained for two days in the solution of cadmium sulphate I found :—

	No. 1	No. 2	No. 3	
e_2	− 0·0060	− 0·0067	− 0·0091	Mean value − 0·0073 D

These values remained quite constant; I left, *e.g.*, the cadmium rods (No. 1) for a day in the solution of cadmium sulphate after the constant state had been reached and found $e_2 = -0·0059$ D.

If the amalgamated cadmium was re-amalgamated the value became again the same. Thus, I treated the amalgamated cadmium rod belonging to No. 2 in this manner, and found $e_2 = -0·0450$ D; after a time it became $= -0·0100$. The result was similar when the external layer of the amalgamated cadmium was eaten away with a strong acid. The surface had then again an appearance like that of mercury, and the original value of the electromotive force was re-established. Thus the amalgamated cadmium belonging to No. 1 was treated in this manner, and e_2 became then $= -0·0398$ D, and after some time again $-0·0059$ D.

From these experiments it is probably permissible to conclude, that—

In a concentrated neutralised solution of cadmium, sulphate amalgamated cadmium is negative to non-amalgamated cadmium; the potential difference between them is considerable immediately after amalgamation, but decreases in time to a certain limit.—*Wiedemann's Annalen.*

NEW GALVANOMETERS.

ON A NEW REFLECTING GALVANOMETER OF GREAT SENSIBILITY, AND ON NEW FORMS OF ASTATIC GALVANOMETERS.*

By THOMAS GRAY, B.Sc., F.R.S.E., and ANDREW GRAY, M.A., F.R.S.E.

(Communicated by Sir WILLIAM THOMSON, F.R.S.)

THE paper describes first a very sensitive galvanometer, of novel construction, which the authors have constructed, with aid from the Government Research Fund, for their experiments on the electric resistance of glass and allied substances. It consists of two pairs of coils with hollow cores, arranged so that the axes of each pair are parallel and in a vertical plane, which act on a needle system, consisting of two horse-shoe magnets of thin steel wire, connected by a very light frame of aluminium, and hung with their planes vertical, so that a horse-shoe corresponds to each pair of coils, and has its poles within the hollow cores. In the instrument constructed each pair of coils is carried by a vertical brass plate, and these two plates are set so as to make an angle with one another of about 106°. A line drawn from the suspension thread (a single fibre of silk) to the position of a pole of either of the needles, when the needles are at the same distance within both pairs of coils, is nearly at right angles to the axis of the coil, and the motion of the needle for small deflections is nearly along the axis. The needles enter the coils from the same side, and the current is usually sent through the coils, so that one pair cause their horse-shoe to move outwards and the other pair their horse-shoe to move inwards, thus turning the needle system round the suspension fibre. A mirror fixed to the aluminium connecting bar gives a measure of the deflection in the ordinary manner.

A magnet (or magnets) is generally arranged to give a differential field at the upper and lower ends of the needles, which are usually placed with unlike poles turned in similar directions: but any magnetic system may be employed to give directive force in the proper manner and degree for a particular purpose or arrangement.

Another form of the instrument is described in which the coils are all in one plane, and the connecting aluminium bar carrying the horse-shoe needles passes through the plate in which the coils are set from one side to the other, so that one horse-shoe enters its pair of coils from one side and the other horse-shoe from the other side. When the needle system is deflected thus, both needles are pushed out of the coils or both pulled in.

By the method of arranging the needles and coils adopted in these instruments the current is made, when the hollow cores are made small, to act very advantageously on the needles, and hence in great measure their high sensibility. By using a small needle to give directive force, the great magnetic moment and leverage of the horse-shoes may be taken advantage of.

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* Abstract from paper read before the Royal Society.

The paper then describes a new and very compact form of distributing plate, by means of which a multiple coil galvanometer, or one in which the coil is wound in sections, may be connected in any desired manner to vary its resistance or its sensibility.

Finally, two forms of instrument, in which two perfectly vertical and straight needles connected together rigidly by bars of aluminium are used to give a perfectly astatic system, not disturbed by the magnetising or demagnetising action of neighbouring magnets. Two vertical needles, with their upper ends in the position occupied by the upper needle of an astatic galvanometer, and their lower ends in the position of the lower needle, experience, if their like poles are turned in dissimilar directions, a similar electromagnetic action to that in the horizontal needles.

REVIEWS.

Electricity in Theory and Practice; or, the Elements of Electrical Engineering. By Lieut. **BRADLEY A. FISKE**, U.S.N. New York: D. Van Nostrand, 23, Murray Street. London: E. and F. N. Spon, 16, Charing Cross.

The design of this book is to form a bridge between the many works written on the theory of electricity and the many works written on its practical applications. We have some doubt whether the need of books of this class is really felt, though there is an increasing tendency to publish them. We fancy that for general readers a connecting link hardly supplies the place of the two branches which it connects; whilst for those who are really interested in electrical subjects the books which deal with the two branches in question will be found sufficient, as they usually terminate, on the one hand, and commence, on the other hand, at those points which render a connecting link quite unnecessary. If we admit, however, that the want of such a link is necessary, Lieut. Fiske has shown great capability in forging it. The book is written by a writer who knows his subject, and who has the faculty of clear exposition. The author's explanations of the units are very good, and are given in a style which might be followed with advantage by many, as the writer is evidently aware of the difficulties which many labour under in following the usual explanations, and does not imagine, as many instructors undoubtedly do, that what is clear to the teacher is necessarily equally clear to the pupil.

The book, it may be remarked, consists of 270 pages, and is printed in large type, with conspicuous headings —a point which is by no means unimportant. The illustrations are numerous, and generally satisfactory.

Absolute Measurements in Electricity and Magnetism. By **ANDREW GRAY**, M.A., F.R.S.E. London: Macmillan and Co.

This book is practically a reprint of some papers by the author contributed to *Nature;* but considerable additions have been made, which render the treatise a very able and useful work. A great defect lies in the absence of illustrations, which necessitates somewhat laboured and lengthy explanations necessary, in order to describe certain instruments. The book is the nearest approach we have yet had to a familiar explanation of the electrical units, but it lacks to some slight extent the spirit which animated the author of the book last noticed.

As a pupil of Sir William Thomson, the author is, no doubt, somewhat biassed in favour of that gentleman's graded galvanometers, and, consequently, we have very full descriptions of these instruments. Our own experience, we must confess, is not greatly in favour of the apparatus as it is apparently intended to be used—in fact, we are of opinion that too much is claimed for them, and that very grave errors may arise from a comparatively unintelligent use of it. There are points in the instruments which show the inventor's mechanical genius, and which render the instrument easy of adjustment, and accurate, in *certain respects*, through a great range. If, however, we are to depend, as the inventor practically intends we should, upon the regulating magnets remaining of constant magnetic intensity, we should be extremely sorry to guarantee the accuracy of our measurements. Experience has again and again proved that permanent magnets will not retain their magnetic intensity constant except under circumstances which are very rarely met with in practice; and, therefore, to mark on the magnets of his galvanometers, as Sir William Thomson does, that the intensity is of a given value is decidedly misleading; and the fact that it is stated that the determination was made on a particular date is practically of no account. Either the magnets can be relied upon absolutely, or they cannot be relied upon at all, and this ought to be properly recognised.

*The Motors for Electrical Machines, with reference to Theory, Construction, and Working.** By **TH. SCHWARTZE**. Vienna, Pesth, Leipzig: Hartleben.

The work before us forms the 21st volume of the "Electrotechnical Library," and deals with the sources of motive power for dynamos and other electric machines. It has, indeed, been prophesied that the age of steam is coming to a close and the age of electricity is about to take its place. How this forecast is to be realised it does not, for the present, appear. So far, as the author remarks, electricity affords the means of transmitting power rather than of producing it initially. The most economical means of obtaining an electric current, according to our present knowledge, is the dynamo machine, but to set it and keep it in motion some source of mechanical power is needed —steam, wind or water, according to circumstances. Perhaps, in time to come, the difference of the electric tension of the earth and air may be utilised. If this is found practicable on a large scale, then, and not till then, we may speak of steam being superseded. In the meantime, it is prudent to consider in what manner known sources of mechanical power may best be turned to account.

So far, as we learn from the book before us, this is done but in a very imperfect manner. The reasons why wind and water should be utilised wherever possible is, that unlike steam raised by the combustion of coal, they occasion no nuisance and, at the same time, they expend not the world's capital but merely its revenue—if that. We say "if that," because no more of the earth's resources or those of the sun are consumed if we apply the wind and the falling water to useful purposes than if we allow them to sweep by unemployed.

In windmills, or rather wind-wheels, great improvements have been effected, *e.g.*, Halladay's "standard windmill," which is here described and figured. This device differs from the primitive windmill in being self-adjusting, both as respects the pressure and the direction of the wind, so that the working power remains nearly constant. These mills or wheels seem to us especially suitable as a source of power in England, where prolonged calms are of very rare occurrence. Of course, in many cases the mill may be made to pump up water to a height, the descent of which works any required machinery. If the store-tank is sufficiently large, any ordinary calm will be provided for. The author considers that a single windmill is an economical and available motor from $\frac{1}{15}$th to 4 horse-power. Where this is not sufficient, the mills must be multiplied. Coulomb, however (here quoted), maintains that he has produced an available effect of 7 horse-power from a windmill. The working cost of a self-regulating windmill, including lubricants, repairs, depreciation, and interest on capital, is calculated at about one penny per horse-power hourly.

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* Die Motoren der Elektrischen Maschinen mit Bezug auf Theorie, Construction und Betrieb."

Water-power is, relatively speaking, still more neglected than wind-power. France and England have done more in developing their resources in this direction than any other European countries. Yet we are told that in Great Britain and Ireland 900,000 horse-power yearly are going to waste.

In Germany the loss is about 1,200,000 horse-power.

There is a very great probability that the electric transmission of power will open up quite a new epoch in the utilisation of waterfalls, rapid currents, &c. Chretien and Felix, in France, have succeeded in this manner in conveying the power of turbines to great distances and making it available for ploughing, threshing, and mowing by machinery. Water-power is also available for working electric railways, propelling boats on canals and rivers, &c. Menier, of Paris, conveys 70 horse (water) power to a distance of 5 kilometres.

The question, of course, arises, in what manner the descent of water is to be applied? The author is of opinion that well-constructed water-wheels are equal in their degree of efficacy to turbines. But a water-wheel never acts so regularly as a turbine; if well built, it is often the more costly of the two; it takes up more room, requires a more considerable outlay in repairs, and, on account of its slow rotation, it necessitates more complicated machinery in order to gain the needful velocity. Hence, in almost all cases, the preference must be awarded to the turbine. The common notion that the turbine is inapplicable where the fall of water is trifling, is shown to be incorrect; good work has been obtained with a fall as low as four feet.

As regards theory, it is laid down that turbines are impelled by the *vis viva* of the water. Into the long and thorough-going consideration of the different constructions of turbines, as adopted in France, Switzerland, Germany, and America, space does not allow us here to enter.

The author next passes over to what, though in many respects the least desirable, is still the commonest and, under many circumstances, the most economical source of power—the steam-engine. It is almost humiliating to admit that after so much has been thought and written concerning this prime factor of modern industrialism—after so many decades of experiments and improvements—we only obtain one-eighth of the heat-energy expended in the shape of available work, the remaining seven-eighths being simply wasted. This waste is a most lamentable circumstance; it increases the consumption of coal, and with it the accompanying nuisances, and powerfully contributes to raise the cost of fuel. Such then is the loss when heat is generated by the oxidation of carbon at high temperatures. On the other hand, the oxidation of carbon without luminous flame, or high temperatures, as it takes place in the bodies of living animals is far more economical, *i.e.*, a far higher proportion of the heat evolved is transformed into mechanical power. Here, however, we are still in the position of mere tyros. We always associate the combustion of fuel with the production of light. Yet in some public experiments performed by Mr. Fletcher, of Warrington, in the laboratory of the Owens' College, Manchester, common coal-gas was made to burn without visible flame, and yet to produce effects which have not yet been practicable. It may be, therefore, that we are on the eve of a new departure in the production and application of heat. The author speaks of a process by which the dynamic heat generated by the oxidation of petroleum in non-conducting vessels may be utilised.

Of the solar engine the author speaks by no means hopefully, less hopefully, we think, than the facts warrant. In Europe, indeed, such devices are merely ridiculous. But beneath the skies of Africa and Australia the case is very different. It is, we understand, admitted that in the latter country food can be thoroughly cooked by being placed in a covered pot, blackened externally, and screened from the wind, but without the aid of either burning-glasses or reflectors. Surely then, if the boiler is inclosed, as in Mouchot's machine, in a case of clear glass, which gives ready passage to the sun's rays, but almost entirely prevents the escape of low tension heat rays, steam may be generated at a useful pressure.

A very large portion of the book is devoted to a description of the steam-engine and its accessories—boilers, furnaces, &c. We must be permitted to doubt the utility of this section, since it concerns the electrician only in common with other consumers of steam power, and since the subject is one which has been repeatedly and copiously treated in technological works.

The hot-air, or, as they were formerly called, "caloric" engines are next examined. The expectation that these devices would prove more economical than the steam-engine has not been fulfilled. The air can be heated to a moderate degree only, and the necessary permanence and absence of leakage could not be secured.

These engines have been found available only to the extent of one to two horse-power, and even then display many defects. The Ericsson engine, and even the improved type patented by Lehmann, are not likely to be applied for driving dynamo machines.

The gas-engine is superior to the steam-engine as regards the utilisation of heat. The Otto machine converts 18 per cent. of the heat generated into work, which is more than double the result of the best steam-engine.

The last chapters of the book are taken up with an account of regulators and of dynamometers.

The work will prove a useful manual of reference and a safe guide to electricians in selecting the most convenient motor for their installations.

THE ELECTRICAL TRANSMISSION AND DISTRIBUTION OF ENERGY.*

By MARCEL DEPREZ.

THE author will explain briefly, but nevertheless in a complete manner, the fundamental laws of the electric transfer of energy. He will not hesitate to go back to the first principles, and will be scrupulously careful to define and to demonstrate everything in order to furnish an absolutely substantial explanation of the whole. He will employ, in his demonstration, merely simple physical principles and formulæ of the most elementary algebra, a procedure which will have the advantage of introducing into his explanations a geometric evidence which leaves the understanding completely satisfied.

It is proper here to recall what is understood by the term *energy*. This term comprises work in all its forms. We know that all physical phenomena, of whatever kind, can be estimated in units of work, *e.g.*, in kilogrammetres. In this manner we may express chemical reactions and thermic changes. An important principle results from these measurements, it is the following:—If we have a certain quantity of energy in a measurable form, such as the work expended in moving a generator of electricity, we may employ it, either in its entirety to produce an energy of any given form, *e.g.*, heat, or to produce at once different forms of energy, heat, chemical action, motion; in all these cases the sum of the energy produced is equal to the work expended.

This may be expressed in a general manner in the following form:—

$$T = A + C + T_m + \frac{\Sigma m v^2 - \Sigma m v_0^2}{2}$$

In this equation T represents the value of the work expended to move the generator, C, the thermic action, T_m, the work performed by the motors $\frac{\Sigma m v^2 - \Sigma m v_0^2}{2}$ the modifications of *vis viva* of the organs of these motors. It will be remarked that electricity does not figure in this equation; there is, in fact, no means of introducing it; electric work has no expression and does not exist in a special form. It manifests itself always in the form of thermic or chemical work, &c., and not in a special manner, except in the case where we condense electricity. In this case only there is electric work. We are, therefore, forced to conclude that electricity is not one of the forms of energy, but is merely its vehicle—a very striking consideration which will cease to appear strange if we reflect that in work produced electrically there is no loss of electricity. As we shall see below this reappears intact after having yielded various amounts of energy—a result which would be absurd, if electricity itself was energy. The only element which is modified in this case is not the quantity of electricity, but merely its potential, which represents energy, and not electricity itself. It is no more a form of energy than is a column of compressed water or a medium of transmission. We shall have to return to this subject when we have expounded the theory of electric motors.

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* *La Lumiére Electrique.*

This is the principle known as the conservation of energy, and it is moreover, as we may say in passing, a direct consequence of the laws of rational mechanics.

DEFINITIONS AND PRINCIPLES.

I.—*Definition and Measurement of the Intensity of a Current.*

As we shall make use of electricity in the form of a current, we must, in the first place, define exactly the terms which we shall employ and distinguish the elements which have to be introduced into the demonstration.

It does not appear useful to define the electric current itself; the phenomenon thus named is known to every one, but it possesses distinct qualities which require to be studied separately.

We will first examine that which is called intensity.

Among the results produced by the passage of a current we will especially consider its chemical action. The simplest examination shows that it is a function of the intensity of the current; we see it produced more or less strongly, according to the variations of this intensity. Without as yet specialising the relation which connects them, we recognise it as evident that equal chemical reactions correspond to equal intensities and reciprocally. This phenomenon is the first which has served for a method of measuring electricity. Chemical action having been the first generator of dynamic electricity, could not fail to be adopted as its standard.

The Laws of Faraday.

a. The laws which regulate electro-chemical reactions were discovered by Faraday. The first of these laws is enunciated as follows: if we form a circuit traversed by an electric current, whatever may be the nature and the arangement of the successive conductors which enter into the circuit, the chemical work performed and, consequently, the intensity, *i.e.*, the quantity of chemical action and of electricity per unit of time, are the same at all its points.

b. This law is verified in the following manner: in a circuit in which a battery is in action, we place in succession a certain number of voltameters, purposely selected as unequal, either in size or in conductivity (which is effected by acidulating the water which they contain more or less strongly). In spite of these differences, the volume of gas liberated in each in a unit of time will be the same.

c. The chemical work performed is the same, not merely in the voltameters placed in the circuit, but in the battery itself. To demonstrate this truth we construct an element by placing in acidulated water two plates, the one of zinc and the other of platinum, the latter being covered by a glass jar filled with water. On making use of this element as the generator, we shall see hydrogen evolved upon the sheet of platinum in a quantity precisely equal to that which is liberated in the bells of the voltameters placed in the circuit. The battery, therefore, acts like any other apparatus submitted to the action of the current, the chemical reaction and the intensity at the points of the circuit where it is placed being the same as at all others.

d. On carrying the experiment further, we may employ as a generator the gas element of Grove. This is a real voltameter, the bells of which are filled respectively with oxygen and hydrogen. We know that if we connect the platinum wires immersed in these two bells, we obtain a current. On forming a circuit with a certain number of these elements and a smaller number of voltameters, we see that the quantity of gas absorbed in each element of the battery is equal to that evolved in each of the voltameters. If we then remove a certain number of the elements of the battery, so that the voltameters are more numerous, these, in their turn, become the generators of the current and the action re-commences in the inverse direction. The chemical work effected in one and the same circuit is, therefore, always equal, not merely whatever may be its situation, but whatever is its direction, whether positive and employed to create a current, or negative and produced by its action.

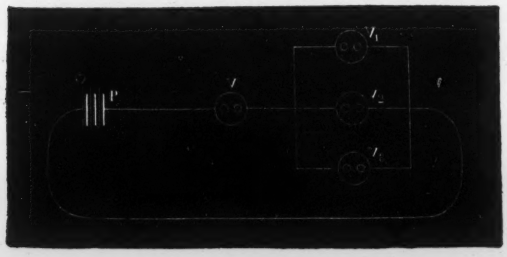

FIG. 1.

The foregoing reasoning pre-supposes merely that to equal intensities of the current there correspond equal chemical reactions, without our having tried to determine more closely the relation which exists between intensity and chemical action. This we must now do.

e. The chemical action is proportional to the intensity of the current.

To demonstrate this, let us place in some one point of the current a voltameter, V (fig. 1); at another point let us divide the current into three branches, in which we place three identical voltameters, V_1, V_2, and V_3. At this latter point the current, finding three equal routes, will divide itself into three branches, the intensities of which will be, of necessity, equal, and each of which will represent a third of the total intensity. We then shall find in each of the voltameters which thus receive these divided currents, a volume of gas equal to one-third of that contained in the voltameter where the entire current passes; this demonstrates the law.

We have hitherto supposed that in the whole extent of the circuit there occurs merely one chemical action, that of the oxygen upon the hydrogen, which in our experiments is active in one direction and passive in the other.

The law holds good in cases where the current produces, at the same time, various different reactions; the weights of the chemical compounds formed in the battery, and the weights of those decomposed by the current are not then equal, but proportional to the chemical equivalents of the bodies concerned. As batteries are generally used where the substance dissolved is zinc, we might express this law, the law of electro-chemical equivalents in the following terms:—

In any circuit in which a current produces any chemical reaction whatever, as many equivalents of zinc will be dissolved in each element of the battery as there are equivalents decomposed in each electrolytic apparatus, supposing the elements and the apparatus arranged in tension in a single circuit.

II.—*Definition and Measurement of the Electromotive Force.*

The cause which sets electricity in motion in the circuit is named electromotive force. It can be simply and clearly estimated by the number of the elements of the battery which we employ, if these elements are placed one after another, so as to form a single circuit, in which their action is accumulated. They are then, as it is commonly worded, arranged in series or in tension.

Tension is a special form of electricity, and indicates the state of accumulation in which it exists. Coulomb has studied its laws for static electricity; exact experiments show that these laws apply equally well to dynamic electricity. Very sensitive instruments reveal, at different points of a circuit, tensions analogous to those met with in static electricity, but much more feeble. If we take, *e.g.*, a Daniell's element, the circuit of which is not closed, we find between the poles a difference of electric tension, the greatest which this battery can produce. This difference of tension is then equal to what we call the electromotive force of the battery. This is not otherwise known to us, as we shall show below, save by the differences of tension which it produces, and which serve for measuring it. If we connect the two poles of the battery to the ground, and follow the wire which proceeds from one of them, we find tensions which decrease progressively from the pole to the ground, where the tension is null. In this case we say, according to a modern term, the mathematical signification of which represents a well defined function, that the different points of the circuit have decreasing potentials. We may determine the differences of these potentials by taking, *e.g.*, as unity, the potential of the battery with an open circuit, which we call the electromotive force of the Daniell element. An electric movement, a current can exist between two points only, when there exists between them a difference of potential. It can no more be conceived between two points in the same electric state than can a current of liquid between two points situate on the same level. Hence we derive a direct means of measuring the difference of potential of two points. Suppose that we are speaking of the points, M and N (fig. 2), situate in the circuit, A, B, where a current is passing in the direction, A, B. We take between, M and N, a derived circuit, M, P, N, upon which we arrange any apparatus whatever, G, fit for showing the passage of a current. It will at once show an action resulting from a derivation of the principal current which circulates in the direction, M, P, N. We introduce then into this circuit at, P, Daniell's elements tending to cause a current to pass in, P, M, N, in the opposite direction, and we increase the number of the elements until there is no longer any current at G. The current of the battery then annuls the derivation, *i.e.*, its electromotive force exactly counterbalances the difference of potential between the points, M and N, it is equal to that difference and furnishes its measure.

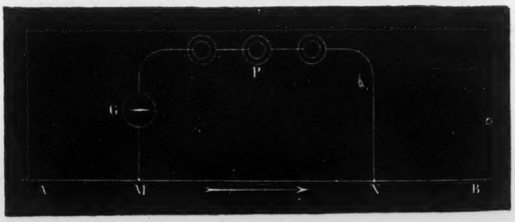

FIG. 2.

Possessing thus the means of measuring an electromotive force, or a difference of potential, we can examine how a current varies according to the conditions in which it is found.

III.—*Definition and Measurement of Resistance.*

Upon the circuit of a battery let us place a voltameter, connected with it by a wire of known length. There is evolved a certain quantity of gas per minute. If we increase the length of the wire interposed between the two pieces of apparatus we shall see the quantity evolved per unit of time diminishing. It will be the same if we decrease the diameter of the wire. The contrary will take place if we decrease the length of the wire or increase its section. The bodies which are traversed by the current act, therefore, as obstacles which cause its intensity to vary. According to their nature and their dimensions they act as resistances greater or smaller, and there is between the intensity the electromotive force and these resistances a certain relation.

(*a*.) Ohm has demonstrated by mathematical considerations that this relation is the following:—$I = \frac{E}{R}$, I representing the intensity, E the electromotive force of the battery, and R the total resistance of the circuit. We say *total*, because we must take care to include in it not merely the resistance of the wires and the apparatus but also that of the batteries. The battery is not in fact distinct from the rest of the circuit. It forms an initial point, but both for chemical action, as we have just seen, and for resistance, it enters into the general law, and must count in the sum of the resistances.

Nevertheless, in the course of these explanations, and when merely examples or demonstrations are concerned, we shall, for the sake of simplicity, overlook this resistance—the so-called internal resistance—though in reality it is never null, and consider merely the external resistance.

(*b*.) The law of Ohm is more general than we have stated. It applies not merely to an entire circuit, but also to a portion of a circuit. We write then $I = \frac{e}{r}$, I representing, as before, the intensity, e the difference of potential at the two ends of the portion of the circuit in question, measured as said above (section II., *a*), and r the resistance of this portion.

The laws of Ohm have been verified by Pouillet, Fechner, Despretz; they are constantly applied, and are unceasingly verified in daily practice.

The discovery made by Oersted of the action of the current upon the magnetic needle furnishes a means of detecting the existence of currents and of measuring them by phenomena more convenient than the chemical reactions which have hitherto served us for a standard. We will in future suppose that these instruments, known under the general name of galvanometers, will be employed.

On the other hand, the different magnitudes which a study of the current requires us to measure—the principle of which, *i.e.*, electromotive force, resistance, and intensity, we have just enumerated—have their special units. These units have been elaborated upon special theoretical ideas by the British Association for the Advancement of Science, and have been definitely adopted by the Congress of Electricians.

It does not fall within our plan to give their precise definition. We shall merely give their name, because they are convenient for use, and we shall have to employ them.

The unit of tension or of electromotive force is the volt, the unit of resistance is the ohm, and the unit of intensity has received the name of ampère.

According to Ohm's law, quoted above, the relation between these three units may be thus expressed:—

$$\text{Unit of intensity} : = \frac{\text{Unit of electromotive force.}}{\text{Unit of resistance.}}$$

TRANSMISSION OF ENERGY.

IV.—*Transmission of Chemical Energy.*

These preliminaries being established, we may pass to the study of the transfer of chemical energy, which we shall at once examine.

a. When we make use of the galvanic battery to produce chemical reactions, there are necessarily actions in two directions, positive in the battery where they generate the current, and negative in the apparatus, where this current effects electrolytic decompositions. Referring to the illustrations and the examples given in the paragraphs I., *a*, *b*, *c*, it will be remembered that these actions are equal at all points of the circuit and in all the elements which act, whatever may be their direction.

We will consider more closely the experiment section I., *d*, in which Grove's gas elements, arranged in series, decompose water in the voltameters. Let N be the number of Grove's elements so arranged, and n that of the voltameters. These two series of similar apparatus give rise to electromotive forces opposite in direction. According to the definitions given in section II., the electromotive force of an element being P, that of N gas elements will be $N P$, and that of the n voltameters $n P$. The relation of these forces is $\frac{n P}{N P}$ or $\frac{n}{N}$

The chemical action being the same at all points of the circuit, there will be as much gas produced in each of the gas elements as there will be evolved in each of the voltameters. If we call Q the volume evolved in the unit of time, then the gas elements will have absorbed $N Q$, whilst the voltameters will have evolved $n Q$. The relation of these numbers $\frac{n}{N}$ express the proportion between the useful work produced and the work expended. We see it is equal to the relation of the positive and negative electromotive forces. This figure is the economic yield of the apparatus; it expresses the expenditure which a certain amount of work produced necessitates under the conditions of the experiment.

We see that it varies according to the arrangements adopted. If we wish, *e.g.*, that this relation should = 1, we must make $n = N$, but then the direct and inverse electromotive forces being equal, there will result no work at all. If, on the contrary, we increase N in proportion to n, the work produced costs more and more. It is true that it is effected more and more rapidly, and that the quantity evolved per unit of time increases in proportion as the economic return diminishes. We must not forget that in consequence of the resistance of the circuits there is always heat produced in the passage of the current. It is in this form that the portion of work produced by the battery and not recovered in the form of useful work, is expended.

In the above calculation we have not taken into account the distance which separates the active and passive apparatus, or the resistance of the circuit which this distance represents. It will be necessary to examine its influence.

Let us estimate the work expended and recovered. We have just said that if we call Q the quantity of gas collected in a voltameter or expended in an element of the battery, the useful work is $n Q$, and the work expended $N Q$; but we know that the chemical action is proportionate to the intensity (section I., *e*). Therefore, Q is proportionate to I, and the work is proportionate to $N I$. On the other hand, I is known by Ohm's law; it is equal to the electromotive force divided by the resistance. The electromotive force in this current, or when there are two opposite currents, will be the differences of these two forces, and will be represented by $N P - n P$; the work expended in the battery will, therefore, be

$$N \frac{N P - n P}{R},$$

and the work recovered

$$n \frac{N P - n P}{R}$$

Their relation, as we have seen, is $\frac{n}{N}$, and does not depend on the distance. The value of each of these works, on the contrary, depends on the distance, and if we cause the distance to vary without changing anything in the arrangement of the system the values of the two works will vary.

The matter may be arranged so that this does not take place. In fact, the absolute chemical work produced in a unit of time, as well as the economic return, will remain invariable, whatever may be the distance, on condition that the direct and inverse electromotive forces shall vary proportionally to the square root of the resistance of the circuit.

To demonstrate this let us return to the experiment (Section I., *d*). In this experiment the current resulting from the difference of the opposing electromotive forces, $N P$, and $n P$, has, according to Ohm's law, the intensity—

$$\frac{N P - n P}{R}$$

R representing the resistance of the circuit. The economic return has the value $\frac{n}{N}$. Suppose that the distance, and consequently the resistance, becomes 25 times greater, but that in place of the numbers, N and n, let us introduce into the circuit, according to the rule which we have just given, $5 N$, gas elements, and, $5 n$, voltametres, 5 being the square root of 25. The intensity of the current will be then:

$$\frac{5 N P - 5 n P}{25 R,} \text{ or}$$

$$\frac{N P - n P}{5 R}$$

It will then be five times smaller than the former; the chemical actions in each of the elements will then be five times less energetic, but as there are on each side five times more elements than before, the total quantities expended and produced per unit of time, as well as their proportions, will remain the same.

These various theorems which have been established, from considering merely gas elements, apply to every kind of chemical action; the quantities expended or recovered cease, indeed, to be identical, but in accordance with the law of electro-chemical equivalents (Section I., *e*), they do not cease to be proportioned to the same numbers, and the results will be the same.

We can now sum up the consequences of these theorems.

Still, a preliminary remark is necessary. We have just estimated the total positive work and the useful negative work; we have found that they are proportional to the numbers, $N I$ and $n I$, in which I represents the intensity, N the number of positive elements, and n the number of negative elements. It follows that these works are equally proportional to $N P I$ and $n P I$, P being as before, the electromotive force of an element of the battery. $N P$ then expresses the total positive electromotive force which we will call, E, $n p$, the total negative electromotive force, e, and the expressions of the work become $E I$, and $e I$. These expressions, more general, are those which give the measure of the the work. $E I$, is the measure of the total chemical work expended, and $e I$, the measure of the useful chemical work produced.

This remark having been made we can formulate the conclusions to which we have been led.

1. The positive chemical work representing the total chemical work expended is expressed by $E\,I$; for any given intensity it is therefore proportional to E.

2. The negative chemical work is expressed by $e\,I$, and for any given intensity it is proportional to e.

3. The economical return is equal to the ratio of the negative electromotive force to the positive electromotive force.

4. The chemical work expended, the useful chemical work and the economic yield remain constant, whatever may be the distance of transport, provided that the electromotive forces, positive and negative, vary proportionally to the square root of the resistance.

(To be continued.)

ON AN EXPLANATION OF HALL'S PHENOMENON.*

By SHELFORD BIDWELL, M.A., LL.B.

Mr. E. H. Hall's papers, giving a full account of his well known discovery are printed in the *Philosophical Magazine* for March, 1880, November, 1880, September, 1881, and May, 1883. His original experiment was as follows:—A strip of gold leaf was cemented to a plate of glass and placed between the poles of an electro magnet, the plane of the glass being perpendicular to the magnetic lines of force. The current derived from a Bunsen cell was passed longitudinally through the gold, and, before the electro-magnet was excited, two equipotential points were found by trial near opposite edges of the gold-leaf, and about midway between the ends: when these points were connected with a galvanometer, there was, of course, no deflection. A current from a powerful battery being passed through the coils of the magnet, it was found that a galvanometer deflection occurred, indicating a difference of potential between the two points, the direction of the current across the gold leaf being opposite to that in which the gold leaf itself would have moved across the lines of force had it been free to do so. On reversing the polarity of the magnet, the direction of the transverse electromotive force was reversed; and when the magnet was demagnetised the two points reverted to their original equipotential condition.

Subsequent experiments showed that the direction of the effect differed according to the metal used. Thus, with silver, tin, copper, brass, platinum, nickel, aluminium and magnesium the direction of the transverse electromotive force was found to be the same as in the case of gold; with iron, cobalt and zinc the direction was reversed, and with lead there was no sensible effect in either direction.

Hall's results may be expressed by saying that the equipotential lines across the strip are rotated in a definite direction with respect to the lines of force. This effect was attributed by him to the direct action of the magnet on the current; and very great importance has been attached to the phenomenon in consequence of the opinion expressed by Professor Rowland and others that it is connected with the magnetic rotation of the plane of polarisation of light, and thus furnishes additional evidence of an intimate relation between light and electricity.

A number of experiments made by the author convinced him, however, that no direct action of the kind supposed was ever produced, and he ultimately found that Hall's phenomenon might be completely explained by the joint action of mechanical strain and certain thermo-electric effects.

The strain is produced by electro-magnetic action. It will be convenient to refer to the metallic plate or strip (which, for the purposes of this explanation, may be assumed to be rectangular) as if it were an ordinary map, the two shorter sides being called respectively west and east, and the two longer north and south. Let the south pole of an electro-magnet be supposed to be beneath the strip, and let the strip be traversed by a current passing through it in a direction from west to east. Then the strip will tend to move across the lines of force in the direction from south to north. Since, however, it is not free to move bodily from its position, it will be strained, and the nature of the strain will be somewhat similar to that undergone by a horizontal beam of wood which is rigidly fixed at its two ends and supports a weight at the middle. Imagine the strip to be divided into two equal parts by a straight line joining the middle points of the west and east sides. Then in the upper or northern division the middle district will be stretched and the eastern and western districts will be compressed, while in the lower division the middle part will be compressed and the two ends will be stretched. If now a current is passing through the plate from west to east, the portion of the current which traverses the northern division will cross first from a district which is compressed to one which is stretched, and then from a district which is stretched to one which is compressed; while in the southern division the converse will be the case. And here the thermo-electric effects above referred to come into play.

Sir William Thomson, in 1856, announced the fact that a stretched copper wire is thermo-electrically positive to an unstretched wire of the same metal, while a stretched iron wire is negative to an unstretched iron wire. From this it might be inferred, as Sir William Thomson remarks, that a free copper wire is positive to a longitudinally compressed copper wire, and that a free iron wire is negative to a longitudinally compressed iron wire; and experiment shows this to be the case. *A fortiori*, therefore, a stretched copper wire is thermo-electrically positive to a compressed copper wire, and a stretched iron wire is negative to a compressed iron wire. If, therefore, a current is passed from a stretched portion of a wire to a compressed portion, heat will (according to the laws of the Peltier effect) be absorbed at the junction if the metal is copper, and will be developed at the junction if the metal is iron. In passing from compressed to stretched portions the converse effects will occur.

It follows from the above considerations that if the metal plate (which is subjected to a stress from south to north and is traversed by a current from west to east) be of copper, heat will be developed in the western half of the northern division and absorbed in the eastern half; while heat will be absorbed in the western half of the southern division and developed in the eastern half. But the resistance of a metal increases with its temperature. The resistance of the north-western and south-eastern districts of the plate will therefore be greater, and that of the north-eastern and south-western districts smaller than before it was subjected to the stress; and an equipotential line through the centre of the plate, which would originally have been parallel to the west and east sides, will now be inclined to them, being apparently rotated in a counter-clock-wise direction.

TABLE.

S *means stretched.* U *means unstretched.*

Metals.	Forms used.	Direction of Current.	Hall's effect.
Copper	Wire and foil; pure.	S. to U.	Negative.
Iron	Wire and sheet; annealed.	U. to S.	Positive.
Brass	Wire, commercial.	S. to U.	Negative.
Zinc	Wire and foil.	U. to S.	Positive.
Nickel	Wire.	S. to U.	Negative.
Platinum	Wire and foil.	S. to U.	Negative.
Gold	Foil, purity 99·9 per cent.	S. to U.	Negative.
	Wire, commercially pure.	*U. to S.*	
	Jeweller's 18 ct. wire & sheet.	S. to U.	
	Jeweller's 15 ct. sheet.	S. to U.	
Silver	Wire and foil.	S. to U.	Negative.
Aluminium	*Wire and foil, pure.*	*U. to S.*	*Negative?*
Cobalt	Rod: 8 mm. diameter.	U. to S.	Positive.
Magnesium	Ribbon.	S. to U.	Negative.
Tin	Foil.	S. to U.	Negative.
Lead	Foil (assay).	No current	Nil.

If the plate were of iron instead of copper the Peltier effects would clearly be reversed, and the equipotential line would be rotated in the opposite direction.

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* Abstract of a Paper read at the meeting of the Royal Society, February 21st, 1884.

The peculiar thermo-electric effects of copper and iron discovered by Thomson, are thus seen to be sufficient to account for Hall's phenomenon in the case of those metals. It became exceedingly interesting to ascertain whether the above explanation admitted of general application, and the author therefore proceeded to repeat Thomson's experiments upon all the metals mentioned by Hall. The results are given in the following table where those metals which in Hall's experiments behave like gold are distinguished as negative and those which behave like iron as positive.

It will be seen that in every case excepting that of aluminium and one out of five specimens of gold, there is perfect correspondence between the direction of the thermo-electric current and the sign of Hall's effect. With regard to the aluminium, a piece of the foil was mounted on glass and Hall's experiment performed with it. As was anticipated, the sign of the "rotational coefficient" was found to be positive like that of iron, zinc, and cobalt. Either therefore Mr. Hall fell into some error, or the aluminium with which he worked differed in some respect from that used by the author. The anomalous specimen of gold, being in the form of wire, could not be submitted to the same test. It probably contained some disturbing impurity.

It is submitted that the considerations and experiments above detailed render it abundantly evident that the phenomenon described by Mr. Hall involves no new law of nature, but is merely a consequence of certain thermo-electric effects which had been observed nearly thirty years ago.

NOTES.

Electric Lighting.—Messrs. Laing, Wharton & Down have recently, in conjunction with Mr. G. V. C. Holmes and his primary battery, carried out several temporary installations of Swan lamps for dances, evening parties, &c. Amongst others was a ball last week at Kensington, at the house of Mr. Henn Collins, Q.C., and also a dance given by Mrs. Wharton at Old Charlton. The lamps used in all cases have been the low resistance 10 C.P. Swan lamps which, when worked over power, give a splendid effect, and in every instance have given complete satisfaction.

We understand that the Town Council of the borough of Nottingham is prepared to open negotiations with any company willing to light particular districts of the borough by electricity. All communicatons should be addressed to the Town Clerk, Municipal Offices, Nottingham.

The fine steamship *Valetta*, of the Peninsular and Oriental Steam Navigation Company, recently built by Messrs. Caird & Co., of Greenock, has been fitted throughout with the electric light by the Edison and Swan Company. The dynamos are two Edison L machines, which have been altered to run at a lower speed—rather over 500 revolutions per minute—and sustain a somewhat larger number of lights than the normal number, by the strengthening of the magnetic field and certain other modifications. They are each capable of sustaining 150 incandescent lamps of 16 candle-power actual. It is only for a short time during the evening when all the lights on board, amounting to about 240, are required at once, that it is necessary to run both dynamos at the same time. They are driven by a pair of vertical engines, made by Messrs. J. & H. Gwynne, of Hammersmith, running at 270 revolutions per minute, and are geared by means of an endless cotton rope which is wound ten times round pulleys provided with ten U grooves, the last turn being guided back to the proper groove by a pair of small guide pulleys. This arrangement works exceedingly smoothly and is free from liability to break down, besides throwing very little strain on the shafts. The dynamos are placed on slides and by means of screws can be moved forward to compensate for stretching of the rope. The saloon is fitted with four rows of handsome gilded two-light pendants placed over the tables. The state rooms are lighted from lanterns let into the bulkhead, which also throw a light into the alley-ways and are made to carry a candle as well as an incandescent lamp. The engine room, stoke-hole and the various stores, officers' quarters, and forecastle, &c., are all supplied with substantial fittings and are well lighted throughout. The wiring is, as usual in all installations made by the Edison & Swan Company on board ship, run in wood casings securely separating the leads and returns, all main and branch circuits being fitted with fusible plugs. Where necessary, individual lamps are controlled by switches on the socket and a substantial switch board is placed in the dynamo room to which are led the six circuits into which the wiring is divided. These are so arranged that by changing the plugs any circuit may be connected up to either dynamo. During the stay of the *Valetta* in London, previous to her departure on her first voyage to Australia, the light was frequently exhibited to the visitors whom the Peninsular and Oriental Company invited on board. The entire absence of perceptible noise from the machinery was noticed as being an important feature of this installation—one of the most recent and best examples of the application of the electric light to steam ships.

In the House of Commons, on Monday, in reply to Lord H. Lennox, Mr. Campbell-Bannerman said it was not intended to fit the electric light to the smaller class of ships of which the squadron in the Red Sea was composed. Of the ships on the East Indian station, the *Euryalus* alone was of the class usually fitted with the electric light, but she was not so fitted in 1878 when she left England. The *Hecla*, now in the red Sea, carried the electric light, and she had been placed at the disposal of the Admiral.

The Maxim-Weston Electric Company, Limited, has recently supplied an installation of 11 Weston arc lamps, with machinery and fittings, to the Corngreaves Works of the New British Iron Company, Limited, Cradley, near Birmingham.

Telephone.—A deputation, consisting of the Members of Parliament for Portsmouth, the Hon. T. C. Bruce and Sir H. D. Wolff, together with representatives of the Portsmouth Town Council and Chamber of Commerce, waited upon Mr. Fawcett at the General Post Office, on Wednesday week, with reference to the application of the United Telephone Company, to supply telephonic communication to Portsmouth. The Hon. T. C. Bruce, in introducing the deputation, said they were anxious to have similar facilities in Portsmouth to those granted to Liverpool, Bristol, Birmingham, and other large places. There were certain material differences between the conditions imposed by the Post Office for the use of telephones and those offered by the United Telephone Company. The former charged £14 10s. for a half-mile and £18 for above a mile, while for any distance under a mile the company would only charge £12. Beyond this they would erect convenient exchange centres at various points instead of only having one office. Mr. Fawcett, in reply, said it was not necessary to discuss the relative advantages or disadvantages of telephonic communication being applied to any town by the Post Office, or through private enterprise, such as they advocated. He should let the question be determined, as it were, by the proved wants of the public. The important point raised by their deputation was, what were the conditions necessary to attach to a licence given to a private company, keeping properly in view the interests of the public, and the interests of the Exchequer, which, of course, he was bound, as far as possible, to guard. After the trial, in which it was decided by two eminent judges that telephonic communication was infringing the telegraphic monopoly which had been obtained at enormous cost to the taxpayers, the question arose as to what was to be done with those companies which were infringing the legal rights of the Post Office. It was thought, as the infringement was unintentional, that it would be hard for the companies to forfeit the money they had expended in bringing an important scientific discovery into working operation; and, therefore, such companies as had established exchanges were allowed to continue, under certain terms thought necessary to protect the interests of the revenue. After that had been in operation for two years, it was said that he was giving a certain monopoly to certain companies. Other towns and companies applied for licences, and he had to consider whether he should continue his policy, or adopt what he might call free trade under proper conditions so far as his department was concerned. After careful consideration he resolved to adopt the latter, and said that any town, whether the Post Office had established an exchange in it or not, might have a licence for a company under certain conditions, which would give proper protection to the public, and enable the department to come in at any moment to protect the interests of the public with regard to telephonic communication, in case any of the companies to which licences had been given had taken improper advantage of the privileges conferred on them. For this reason, alone, the clauses to which objections had been raised had been inserted in the agreement. The deputation said it was impossible to accept a licence under such terms; but he must tell them that the clauses had been accepted by other companies, and he was willing to give them the exchange on those terms. It was not his wish to establish Post Office exchanges, and cut out private enterprise; and it would afford him the greatest pleasure to hear that a telephonic exchange had been established in Portsmouth, and that it was doing a thriving business. Mr. King said they could not but admit the force of some of Mr. Fawcett's arguments, to which he asked permission to reply by letter. Sir Henry Wolff thanked Mr. Fawcett for his courteous reception, and the deputation withdrew.

The following letter from Mr. E. H. Law, general manager of the London and Globe Telephone and Maintenance Company, appeared in the *Times* on the 23rd ult.:—"The deputation from Portsmouth which was yesterday received by the Postmaster-General on the subject of licenses to telephone companies, and the Post Office, in their claim for the monopoly of all telephonic and telegraphic communication, seems to have been labouring under a slight misapprehension which it would appear to be to the interest of the general public to remove. The Postmaster-General has publicly expressed his willingness to give licenses for the establishment of telephone exchanges to any person who may be prepared to undertake the same, and to accept the Post Office license in a form which was accepted last year by the London and Globe Telephone and Maintenance Company, Limited, and under which that company is establishing and already successfully working a telephone exchange in the metropolis. Many of the conditions of this license are very severe, and it would appear a more natural course for the Post Office either themselves to establish or maintain telephone exchanges wherever required, or to give freer scope to private enterprise; but, as has been shown by the London and Globe Company, none of the conditions are so prohibitive as to prevent the establishing of exchanges wherever there is a fair field. It happens, however, that the United Telephone Company, which, until the successful establishment of the London and Globe Company, was practically without a rival in telephone business in the United Kingdom, does not, for reasons of its own, see fit to accept the form of license now offered by the Postmaster-General, and therefore the United Company is most anxious to bring pressure to bear on the Post Office to alter—nominally for the advantage of the general public—the form of license now offered. The policy of the United Company, for the furtherance of which enormous sums of money have been spent, appears to consist in an endeavour to establish a private monopoly. The conditions of the license offered by the Postmaster-General might, it is considered, endanger this monopoly, and *hinc illæ lachrymæ* on the part of the shareholders of the United Company, and those who, from imperfect acquaintance with the details of the business, have adopted their view of the position. As already mentioned, a working telephone exchange exists in London under the form of license now offered by the Postmaster-General, and arrangements are being made for the establishment, under the same conditions, of exchanges in some of the more important provincial towns. The Postmaster-General is, therefore, not likely to alter the form of his license in favour of any one company when he finds others willing to accept it as it stands, and steadily pushing forward the telephone business.

The Mackay-Bennett Cable.—We read the following in the *New York Herald* of the 13th ult.:—"The Commercial Cable Company, wishing to be independent of any land lines which, as the experience of other companies has shown, are subject to constant interruptions caused by gales and snowstorms, have ordered their cables to be laid double, not only across the Atlantic, but also throughout the entire distance to their landing points in New York and Massachusetts. One cable, landing at Cape Ann, will be able to carry messages direct to Boston and the Eastern States. The other will run up to Fire Island, and thence through the Great South Bay to Coney Island, and right into New York, by means of an underground cable. This route has been carefully chosen with the view of avoiding the danger of possible damage from ships' anchors. Both cables will run down the coast from Nova Scotia in a depth of water not less than 100 fathoms. From the same consideration, Fire Island was selected as the point of destination in preference to Sandy Hook. Mr. Mackay, who has determined that the new cable enterprise shall be a success, has looked after every detail, and has procured every means which a liberal expenditure can command, and the skill of the most experienced electricians can suggest, for providing against all eventualities. A steel repairing steamer of 1,500 tons and 1,400 horse-power, capable of carrying 750 tons of cable besides its coal, and steaming eleven knots, has been ordered from Messrs. Elder, who will build it under the supervision of St. Clare Byrne, for many years manager of Laird's shipbuilding firm. A satisfactory arrangement has also been concluded with Sir Julian Goldschmid, President of the Submarine Telegraph Company, which possesses the monopoly of the right of laying cables across the Channel. The Submarine Telegraph Company by this arrangement, besides granting the right to the Commercial Cable Company to lay their cables, also undertakes, in case of interruption or accident, to convey all their messages directly through their own lines across the Channel until the completion of the necessary repairs. The new submarine cable, instead of stopping at Brest, will run directly into Havre, by which much more prompt and reliable service will be obtained, as it was found in the case of the other companies that the land lines between Brest and Paris were often interrupted by gales, thus causing a delay of several hours. The easterly side of Dover Bay, on the Nova Scotia coast, has been selected as the landing-place of the new cables, but he who undertakes to find the proposed route of the Commercial Cable Company on the map, will probably be baffled by the fact that Dover Bay is not laid down on most maps. If he turns to his gazetteer for information he will be again disappointed, for there is no mention of a mere indentation in the rocks of the coast, which is of no earthly importance to anybody excepting as a place for landing cables. Dover Bay, then, is simply a little sheltered cove in the rocky coast, about five miles to the south of Cape Canso, which is the north-east corner of Nova Scotia. The shores of this bay are inhabited by six families of fishermen, and literally the only industry of the place is fishing. Its availability as a cable landing lies in the fact that it is a little out of the track of the large masses of floating ice that drift southward under the northerly and easterly winds that prevail here much of the time. These ice floes are heavy enough to crush a cable flat against a rock, and the difficulty is to find a course from sea to land that shall be free from this danger. Already Dover Bay has been utilised by the American Telegraph and Cable Company, whose cables are landed on the west side, nearly opposite the landing-place selected for the new cable. The station of this company is situated at Canso, the cable being brought from Dover Bay hither in a trench six or seven miles in length. Dover Bay is a mere indentation in the rocks. A few hundred yards will measure it in any direction, but the rocks at its mouth are rough and bold, and it forms a shelter, with tolerably deep water, perhaps five fathoms in the shallowest places. Were it large enough it would make a good harbour for a fleet. As it is, it is a haven for the boats of the fishermen. Cable Cove, the particular ramification of the irregular inlet in which the shore end of the new cable is to be landed, is large enough for a moderate lawn to a modest suburban villa. It is still more sheltered than the bay, of course, being an opening in the shore of the bay. Here, between two rocks perhaps thirty feet high, the Commercial Cable Company has erected a two-story work-house, which will serve as well for the quarters of three or four men who may be stationed here. This house is a plain, substantial-frame building, close to the beach. It is sheltered by the rocks on both sides, and by a hill close behind it, and faces the little cobblestone beach over which the cable is to be landed. The bottom of the cove has been found to be sandy, and a safe anchorage for the shore end is thus secured."

The Cork correspondent of the *Times*, states that the electricians, representatives of Messrs. Siemens, who have been at Valencia for some time past with the view of selecting a suitable site for the landing of the Bennett-Mackay cable, have finally decided on having the new station at Waterville. This will be within six miles of the Direct United States, and ten miles from the Anglo-American Company's station.

Proposed New Cables.—The Merchants' Telegraph and Cable Company met on Friday, the 1st ult., to perfect an organisation, the following directors being present; The Hon. Thomas L. James, Anderson Fowler, M.D., C. Borden, E. A. Quintard, David Bingham, W. A. Cole, E. R. Livermore, Henry W. O. Dodge, A. D. Straus, John H. Herbert, Henry O. Eyde, George F. Plummer, Edward A. Tobey, and Vernon H. Brown. Officers were elected as follows: President, Thomas L. James; Vice-President, Anderson Fowler; Treasurer, E. R. Livermore; Secretary, Amos Rogers; Counsel, Wayne MacVeagh. Executive Committee, A. D. Straus, Henry O. Eyde, John F. Plummer, E. A. Quintard, and W. A. Cole. Finance Committee, David Bingham, Anderson Fowler, and E. R. Livermore. The new company (says the New York *Electrical Review*) proposes to push forward the work of laying two cables between New York and London direct. The cables are to cost less than any of those that have been previously laid across the Atlantic, and are known as "light cables." They will be constructed differently from those now in use, in that the outside wrappings of hemp are to be twisted in such a manner as to prevent any injury in the paying out. Iron armour or covering will also be dispensed with in the deep sea, and only used when the ocean currents are strong, and near the shore, where the wear and tear of tide and storm is liable to injure the cables. The composition, with the hemp that forms the outer covering, has been found to be impervious to the action of the sea water. The two cables will cost $6,000,000, and they are to be constructed within a year. Over eighty-five per cent. of the cable business is said to emanate from this city, and by far the larger portion of this is of a business nature, of which the new company hopes to obtain a large portion, as its object is to furnish a trustworthy business cable.

The New Telegraph Extension Scheme.—The *Scotsman*, in an article on the extension of the telegraph system, in view of the adoption of sixpenny telegrams, says: "Above ninety towns are enumerated, but as some of these refer to wires which are to serve two or more places, the actual additions to the wires number about eighty. These run to the chief towns in every part of the kingdom, from Aberdeen in the north to Exeter in the south, and the only exception is Ireland, which is, strangely enough, absent from the list. While Scotland absorbs seven new wires (Edinburgh two, Glasgow three, Aberdeen and Dundee one each), we see no reference to Dublin, or Belfast, or Cork, as requiring new wires to London, the only change recorded for Ireland being that the Dublin wires to London are hereafter to be worked 'duplex.' All the new wires stretching from London are to be so worked, and their distribution appears to be general. Liverpool gets three new wires, Manchester two, and Birmingham two; while an eighth wire is being put up for news purposes, working from London to all three towns. The only other places obtaining more than one new wire are Brighton, Leeds, Newcastle-on-Tyne, and Newmarket. The other towns embraced are such as Aldershot, Andover, and Aylesbury at the beginning, Hull, Ipswich, and Jersey in the middle, and Wolverhampton, Yarmouth, and York at the end of the alphabet, these names giving a fair idea of the nature of the places to be so strengthened in their wire connection with London. Within Liverpool eight additional pneumatic tubes will be constructed, between the Exchange, &c., and the head office, and more than a dozen of the local offices will receive new wires. Outside the city three new wires to London and the share of a fourth will be given, as already named; three new wires, 'duplex,' to Manchester, and one each to Belfast, Birmingham, Blackburn, Bristol, Carlisle, Glasgow, Hull, Leeds, and Newcastle. Existing wires will be improved in carrying power, and altogether the service in and around Liverpool shows elaborate preparation. In Manchester, besides the wires to London and Liverpool referred to above, there are more than a dozen new circuits to important towns, and about the same number of local additions or improvements." [It does not appear to be at all certain when the new tariff will come into operation. At all events, the Government has been reluctantly led to the conclusion that the date originally fixed must be postponed, although we understand that the necessary capital for effecting the reduction of rates has already been expended, and that the telegraphic materials are in readiness for immediate erection.]

Personal.—Mr. Radcliffe Ward, consulting electrical engineer, desires us to say that his address for the present remains 110, Cannon Street.

We are glad to learn that Mr. J. F. Albright, formerly of the Swan United Electric Light Company, has been appointed resident engineer to the Edison-Swan company.

The Cable Steamer "Faraday."—We understand that this vessel is now unshipping cable and coals. She must have met with very heavy weather, for it is said that one of the large ocean buoys, fastened on deck, broke loose, tore the ring bolts out of the deck, and getting adrift smashed everything it met on its way and finally, after knocking down a great portion of the starboard bulwarks, went overboard and was lost. Rumour says that two other buoys are also gone. Besides this, she lost all her boats on the port side to the number of six, and her port propeller, as announced last week, is gone. Particulars of the exact damage can only be ascertained when she gets into dry dock.

The Electric Carbon Storage Company of Scotland, Limited.—This case came before Mr. Justice Kay, at the High Court of Justice, on the 22nd ult. An order to wind up the company was made in England on the 15th of August last, and in the winding up an order was made for the sale of certain of the company's property. The sale took place on the 20th of December, and a portion of the proceeds of sale had been retained by the Scotch auctioneer, partly in respect of his own charge for commission and partly in respect of certain claims of Scotch creditors. In consequence of the company's property being in Scotland, actions had been brought in that country against the company, one by an ordinary creditor and one by the magistrates of Leith to recover the amount of rates and taxes due from the company. Certain "warrants of arrestment" (which appear to be a kind of Scotch process in the nature of a stop order) had been served on the auctioneer interdicting him from parting with the money in his hands. One of these arrestments purported to be made *ad fundandam jurisdictionem.* In consequence of the arrestments, the auctioneer had instituted in Scotland an action of "multiple poinding," which is analogous to an interpleader action. Mr. Fischer, Q.C., and Mr. Willis Bund, for the liquidator, moved in all three cases for an injunction to restrain further proceedings in the actions. They further moved for an order on the auctioneer to pay into court the balance in his hands after deducting the amount of his commission. In the first two cases the respondents did not appear, and Mr. Justice Kay made an order in each case restraining the action, and directing the respondents to pay the costs of the application by the liquidator, and further ordered that the liquidator, by his counsel, should undertake forthwith to make the foregoing orders of the Court of Scotland, and that upon that being done, the multiple poinding should be stayed and the money paid into court by the auctioneer.

Metropolitan Brush Electric Light and Power Company, Limited.—The 7th of March has been fixed for the hearing, by Mr. Justice Kay, of the petition of Messrs. Peebles, Andreae, Engel and Sir Edward Inglefield, for the winding up of this company.

Companies' Shares.—The £10 fully paid shares of the Montevidean and Brazilian Telegraph Company were disposed of on Thursday by the Stock and Share Auction and Advance Company at 35s. Last week the £7 fully paid shares of the Exchange Telegraph Company realised £5 5s.

An Electric Bell System.—Messrs. Jensen, Webb, and Jensen, of 103, New Oxford Street, have patented a number of inventions and improvements in electric bells, by which they claim to have really introduced a new system. In the first place, they generally adopt the bell form, and thus produce a musical tone instead of the harsh sound heard upon the common gongs. Then the bell can be hung anywhere, as the mechanism is contained within it, and only a wire communicating with the battery is required externally. In the next place, the bell has a responding attachment, so that a person ringing to a servant can receive, by the servant pressing the button of his or her bell, an intimation that the summons has been heard and will be attended to. For a row of bells in a house there is a visible "annunciator," showing from what room a bell has been rung, and the replacing of this signal causes a response on the distant bell, so that the person ringing may know the summons has been heard. For bells ringing by clockwork, a connection with any clock is sufficient, so that a factory bell might be sounded from a clock costing only a few shillings; but, of course, in this case a proportionately powerful current would be required. The patentees are applying their principle to a portable electric clock which contains a quantity of wire (as flexible cord), and among the uses to which such an article could be applied is that of detecting the entry of a burglar, for by fastening a small apparatus at the end of the cord to any door, which requires no tools and is the work of a minute, the opening of that door, will be attended by the ringing of an alarm on the bell of the clock.

"Electrical Suggestions."—At a meeting of the members of the Edinburgh Association of Science and Art, on Monday week, Mr. Louis Weston, electrical engineer, read a paper, entitled, "Electrical Suggestions." A short history was given of the development of the dynamo-electric machine, and successive improvements introduced, substituting electro-magnets for permanent magnets, the different methods of exciting them, &c., having been described, a form of thermopile with nickel and iron was explained with reference to its satisfactory working at the present time in depositing large quantities of pure copper in the United States, while its suitability for introduction into houses behind ordinary grates to supply electricity to be accumulated for light at night was pointed out. Coming to recent applications in manufactures, Mr. Weston remarked upon the advantage of ozone as a substitute for chlorine as a bleaching agent, and detailed the results of some French experiments, which show that electricity may be applied to the manufacture of chlorine compounds for bleaching purposes on a sound economic foundation. Mr. Richard Barker's process for obviating the flouring of mercury in the metallurgy of gold was then touched upon, and a new proposal for the extraction of copper, zinc, and lead direct from the ores by electrolysis was explained.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Laing Electric Light and Power Company, Limited.—The annual return of this company, made up to the 18th ult., was filed on the 25th ult. The nominal capital is £1,000,000 in £10 shares; 12,009 have been subscribed, and the full amount has been called up thereon, the calls paid amounting to £120,020, leaving £50 unpaid, the paid up capital thus amounting to £20 more than last year. Registered office: 4 and 5, Three Crown Square, Borough, S.E.

Indian and Oriental Electrical Storage and Works Company, Limited.—An extraordinary general meeting of the members of this company took place on the 4th and 20th ult., when the following special resolution was passed and confirmed, viz.:—"That the capital of the company be reduced from £400,000 divided into 10,000 deferred and 70,000 ordinary shares of £5 each to £280,000 divided into 10,000 deferred shares of £3 10s. each and 70,000 ordinary shares of £3 10s. each; and that such reduction be effected by reducing the liability on each share to the extent of £1 10s., and by reducing the nominal amount of the remaining 5,000 ordinary shares which have been issued as paid up, from £5 to £3 10s. per share." This resolution was duly filed with the registered documents of the company on the 23rd ult.

DISSOLUTION OF PARTNERSHIP.

Francis, Frank Ricardo, and **Fairless, Stuart Douglas,** 17, Hatton Garden, E.C., electric and telegraph engineers. Business to be carried on by F. R. Francis.

CITY NOTES, REPORTS, MEETINGS, &c.

Metropolitan Brush Electric Light and Power Company, Limited.

An extraordinary general meeting of this company was held at the City Terminus Hotel, Cannon Street, on Thursday, for the purpose of confirming the resolutions relating to the winding up of the company, passed at the general meeting held on the 12th February. Mr. Borrer, chairman of the company, presided, and there was a large attendance of shareholders. A circular had been issued by the board, recommending a reduction of capital, in order to avoid the possibility of further calls.

The minutes of the previous meeting having been confirmed, Mr. Peebles, chairman of the committee of investigation, in moving the confirmation of the first resolution, that the company be wound up voluntarily, stated that the liquidators were quite prepared to enter into any undertaking the shareholders might desire to the effect that there should be no further call made upon them, unless an extraordinary general meeting were first held and the call sanctioned, and he might say that there were not the slightest prospects of any necessity for a call. They had in the bank more than ample to pay every claim that could possibly arise, and also to make some return to the shareholders upon their shares. It would never do for them to be handicapped in their action against the strong-backed promoters with whom they had to contend, whose reputation before the world, as well as their pockets, was concerned.

Mr. Tottenham, a director, dwelt upon the possibility of a call having to be made, and expressed his view that it was very probable. With reference to the allusion of the committee in a recent circular to the connection of Mr. Borrer and himself with the promoters, he might say that Mr. Borrer was not acquainted with a single promoter, and he (Mr. Tottenham) only knew one, who had told him that he intended to send his proxy to the committee. The board were supported by a large number of the shareholders, but they would probably be in the minority; and if it was seen that the resolutions already passed were confirmed by a large majority they would not press their suggestions.

Admiral Inglefield stated that directly after the adjournment of the last meeting the committee offered to take over the affairs of the company and carry out the duties which were assigned to them; but that offer met with a refusal. They were ready to take up the matter of disposing of the Provisional Orders, fot which money had been offered, but the opportunity was nor afforded them. If the meeting decided upon any other plan than that proposed by the committee, they must remember that there was an expense of about £8,000 a year going on in keeping up the board and staff, while now they learnt from the directors that there was a sum of £30,000 which might be divided amongst them.

The Chairman said the Provisional Orders were not now marketable, as he was informed that the Board of Trade could not see their way clear to assent to a transfer. He would remind shareholders that no pledge made by the liquidators not to make a call would be binding; while, by postponing action for the short time necessary to reduce the capital they would be secure from all possibility of a call, and would not in any way injure their claim against the promoters. The board did not desire to protect the promoters, and had no sympathy with them; on the contrary, they desired that the claim against them should be pressed, and if an undertaking were given which would be as nearly as possible binding that no call should be made, that was all the directors required.

Mr. Brown having stated that the shortest possible time in which the capital could be reduced would be from three to six months, and that a delay of such length would be extremely detrimental to the action pending against the promoters,

Mr. Engel seconded the motion of Mr. Peebles, to which an addition had been made, making it read as follows:—"The liquidators being present, undertaking that they would make no call upon the shareholders unless authorised so to do by resolution of a general meeting of the company specially convened for that purpose, resolved that the following resolution, passed at the extraordinary general meeting held on the 12th February, be, and the same is hereby confirmed, viz., That in the opinion of this meeting it is desirable that the company should be wound up and that the same be accordingly wound up voluntarily."

The resolution was put and carried unanimously, as also were the subsequent resolutions appointing Admiral Inglefield and Messrs. Peebles, Andreae, Engel, and Bell liquidators, with power to continue the business of the company as they might consider necessary, and authorising those gentlemen to take proceedings against the promoters, and to transfer or sell all or any of the assets of the company, &c.

Mr. Peebles stated that it was the opinion of the committee that the real cause of the dismissal of Mr. Keatinge Pollock was not that he divulged facts relating to the business of the company which he was not entitled to make known, but that he had "strongly and persistently" urged the directors to take proceedings against the promoters. Mr. Pollock having been to a great extent concerned in bringing about the independent investigation of the affairs of the company, and as he had acted energetically in the interests of the shareholders, the committee felt that their thanks were due to him, and he proposed that a vote of thanks to Mr. Pollock should be passed and recorded on the minutes of the company.

Mr. Poole seconded this vote, and the motion was carried unanimously, after which the proceedings terminated. It was understood that the directors ceased to act at the conclusion of the meeting.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.

THE twentieth ordinary general meeting of the shareholders of this company was held at the Cannon Street Hotel on Tuesday, under the presidency of Mr. George Henderson, chairman of the company. The directors' report, which we published last week, showed that the net profits on the past year's business amounted to £48,390 16s.

The Secretary, Mr. W. J. Tyler, having read the notice convening the meeting,

The Chairman said, Gentlemen,—Before I proceed to move the resolution as to dividend, let me congratulate you upon the company's approaching majority. We are about to enter our twenty-first year, and, though we have had our changes of fortune, we hope we have reached a period of reasonable prosperity. Some of our shareholders appear to be dissatisfied that we are distributing among them less than at this time last year. For my own part, I do not feel in the mood to apologise for a 15 per cent. dividend; but if any have bought their shares expecting, as a matter of course, a constant bonus as well as a good dividend, I am sorry, because last year we felt bound to warn you not to count upon this. I will read to you what Mr. Gray said at our meeting in February last: "I want to warn the shareholders that, although we will do everything we possibly can for the success of the company in future, last year was an exceptional year. Don't, I beg of you, get it into your minds that it is going to be easily repeated. I don't mean to say it will never be repeated; I hope it will be, and will be often; but I don't wish that any shareholders should have any anticipation that it is anything like what will usually be the case. I do not wish to depreciate the property, you can well understand that, but at the same time I do not wish to disappoint the shareholders." Mr. Sinclair, a shareholder, one of yourselves, said: "You have given us not only a good dividend, but a bonus. We may therefore, without going very carefully into the matter, consider that the profits are represented by the dividend, and that the reserve carried over and the bonus have been derived from those extraneous profits which are probably only to be had in this year and not any other year. I think it is only advisable that this should be borne in mind by the shareholders, because, when a dividend of 25 per cent. is paid, they are very apt to think that they ought to get the same thing again. I for one think this is probably a peculiar case, and we shall not for some time see such a dividend again. I hope it will come, but I for one—and I hope many other shareholders—consider that we are extremely well paid and receive very good remuneration for the amount we have invested here, if we get the dividend apart from the bonus in future years." When we last met you, six months ago, we were beginning the manufacture of about 2,000 miles of cable to connect Spain with the Canary Islands and Senegal. This has been completed, and about half the quantity—namely, that between Spain and the Canaries—has been laid. Notwithstanding unusual care and patience in preliminary soundings, the work of laying those cables has proved one of considerable difficulty owing to the sudden and great variations in the depth of water and to the rough and rocky nature of the bed of the sea. As to the cable from the Canary Islands to Senegal, it has taken longer than we anticipated for the necessary arrangements connected with the laying to be made, but we expect these will be completed shortly. Our general manager, Mr. Gray, has just returned from a visit to the United States to look up American friends and make new ones, with the view of the further increase of our business. I regret to say our colleague Dr. Beattie has been removed by death since this year opened. His health had been failing for some months, but we had not expected that the end was so near. He had been one of us for 20 years, and his death makes the first breach in our number. His successor, Mr. Scott, who has long been known to us as a shareholder, will, we feel sure, devote his best energies to the company's interest. He retires from the auditorship, and I would suggest for the consideration of shareholders whether a second auditor is necessary. The articles do not require this, and you will probably think, with me, that your interests are safe in the hands of Mr. Weise, of the firm of Messrs. Turquand, Youngs, Weise, Bishop, & Clark. However, we leave this matter to you, as it is one entirely for you to decide. I am glad to tell you that we have begun this year's business satisfactorily. This meeting will be resolved into an extraordinary meeting for the consideration of our bill in Parliament. Meanwhile, I will move that the report and accounts now presented be received and adopted, and that a dividend of £1 per share, tax free, payable on the 27th inst., be now declared.

Mr. Silver, a director, seconded the resolution.

Mr. Verey remarked that in the statement of assets stock-in-trade was reckoned at £189,000. He would like to know how much of that was for the Senegal cable, and also how the Senegal cable was to be paid for—whether in cash or securities, and if the latter, what securities?

Dr. Small thought some explanation was desirable as to the increase in the property account, which was given at £437,000.

Mr. R. W. Smith inquired whether the profits of the company were derived from the ordinary business through the home trade, or whether it was partly derived also from cable work?

The Rev. J. McNaught asked whether the contracts entered into with Governments were taken on such favourable terms as promised as good a profit in the coming time as they had been wont to have in the past, or whether they were taken at such low prices that they would be less profitable?

The Chairman, in answering these questions, said with regard to the first—how much of the item "stock-in-trade" was for the Senegal cable?—he must respectfully, but firmly, decline to answer. Theirs was a trading company, and he could not disclose such information. The Senegal cable would be paid for partly in cash. With respect to Dr. Small's question, they had had to add considerably to the property at Silvertown, and also to the works at Persan-Beaumont, and the money had been spent at those places. As a trading company, they could not answer Mr. Smith's question as to how they made up their profits. With respect to Mr. McNaught's remarks, they had a great deal more competition now, and they had to take their contracts at a lower price than in former times; they got as much as they could, but they had competition, and they must meet that competition.

The resolution was then put and carried unanimously.

Mr. Silver said it devolved upon him to propose the re-election of the chairman. In doing so, he could not but assure them that Mr. Henderson's attention had been unceasing to the interests of the company, and therefore he (Mr. Silver) felt he was acting in their interests in moving his re-election; but it at the same time afforded him very great pleasure.

Mr. Bannatyne said he had very great pleasure in seconding Mr. Silver's motion, and in adding his testimony to the invaluable services the chairman had rendered. A great many of their shareholders had stuck by them for many years, some for eight or ten years at least, and he could not resist the temptation to add a few words to show the position of shareholders who had been with them that length of time, at the present moment, compared with what it was seven or eight years ago, when they re-constituted the capital account of the company. At the end of 1877, their £50 shares were somewhere between £19 and £20 for every £50 share. In the spring of the following year they gave every shareholder three £10 shares; and for every new £10 share one share in the West Coast of America Telegraph Company. The shares of the India Rubber Company were now worth £23 10s. each, and those of the West Coast of America Telegraph Company £6 each, so that the total marketable value was now £88 10s. for what was, at the time he had mentioned, worth only £19 or £20. Although their shares had recently fallen, in this calculation he had taken the present price, and of course, when they were at £30, the amount was much larger. After the services of their invaluable manager, nothing had contributed so much to that very satisfactory result as the continued assiduity of the Chairmain.

Mr. Henderson was unanimously re-elected, and suitably acknowledged the vote.

Mr. H. A. Silver moved and Mr. J. O. Hanson seconded the election of Mr. J. Weise as sole auditor of the company's accounts for the coming year.

Dr. Small did not think one auditor was sufficient. Most companies, even the smallest, had two, and as they were in such a flourishing condition, and progressing as he was glad to hear Mr. Bannatyne say they were, they ought not to do away with one auditor.

The Chairman: It is entirely for the body of the shareholders to decide. I threw out the suggestion because, from what I knew of the working, I thought one auditor was sufficient.

Dr. Small moved that a second auditor be appointed.

Mr. Silver said, practically one auditor did the work. The shareholder merely came in and put his name, and endorsed what the auditor had done.

Mr. George Morton thought Mr. Silver did not give Mr. Scott, his new colleague, the best of recommendations.

Mr. Scott said he had carefully gone through the whole of the accounts, and their accountant took a good deal of trouble to answer the thousand queries he put to him, and he could only thoroughly confirm what Mr. Weise had done. They had in Mr. Weise not one auditor only, they had the whole firm, and one or two of the clerical staff of that firm were wholly employed for about a fortnight, and his experience led him to say that in them they had all the auditors they could possibly require.

Mr. Morton: I am very glad Mr. Scott gives a better account of himself than Mr. Silver gives of him. (Laughter.)

Dr. Small's resolution was not seconded, and the appointment of Mr. Weise was agreed to.

The meeting was then constituted an extraordinary general meeting, and the chairman called upon Mr. Hutchins, solicitor of the company, to explain the purpose for which they desired to frame a Bill.

Mr. Hutchins said: The real reason for wanting the assistance of Parliament arises from the peculiar wording of the memorandum of association, and the memorandum of association cannot be altered by you without the authority of Parliament. I may say the same difficulty occurred to the Telegraph Construction Company, and that last year they went to Parliament and got an Act passed to enable them to do various things which it was very doubtful whether they could do under their memorandum. In the year 1864, when these companies were both established, the thoughts of everybody were on telegraph matters; they did not know, then, into how many branches the application of electricity, magnetism, and so on, would diverge, and the great object in each of the memorandums of association of the companies was to take power to purchase and manufacture wires, hemps, and all other materials and things in any way connected with or incident to telegraph purposes, and we have always found, since the great development of electricity for other purposes, that we were hampered by these words. For instance, the question arose, and was very much discussed by the Post Office and various telephone companies, whether telephone purposes were included in the meaning of the words of the memorandum. In electric lighting, too, it is difficult to say that the wire which produces the light at a great distance from the battery can be properly called telegraphic; and the same difficulty occurs in connection with torpedo wires. Besides all these phases of our manufacture, we do not know what is going to happen in the development of the forces of electricity, magnetism, galvanism, &c. The works are now so laid out that the machinery can be applied to a great many purposes of this sort that were not possible in 1864, and it was thought advisable to go to Parliament to ask for power to alter our memorandum of association so as to give us the very widest powers of turning our machinery, works, and staff to any profitable purpose that may be found open to us connected with electricity. The only other point that I need notice is the question about the foreign works. It was always a doubt in our memorandum whether the original directors ought to have gone in for the works in France, and at one time a committee was appointed to sell those works, together with the works in Belgium. The latter were sold, but those in France were kept, rather reluctantly, because a purchaser could not be found. By degrees, however, prosperity has come to those works, they have been very much improved, and a valuable business is being done there. We want now to prevent any doubt hereafter arising on our memorandum that those works are within the powers of the company, and that they may be retained and used for your benefit.

The draft bill was then read, being merely to formally alter the wording of certain clauses to render clear the right of the company to enter upon the work indicated by Mr. Hutchins.

The Chairman moved that the sanction of the meeting be given to the bill, which was seconded by Mr. Silver, and unanimously agreed to.

A vote of thanks to the chairman and the board of directors, proposed by Mr. Treble and seconded by Mr. Verey, concluded the proceedings.

The Gülcher Electric Light and Power Company, Limited.

THE following communication has been issued to the shareholders of this company:—

Immediately after the election of directors, on the 25th September last, your new board appointed three committees:—(1) investigation, (2) finance, (3) works.

The Investigation Committee.—This committee examined into the origin and formation of the company, and came to the conclusion that £70,000, part of the purchase-money paid for the Gülcher patents, had been paid to persons whom the committee considered to be promoters, and in the position of trustees for the company. The said £70,000 had been received as to £50,000, part thereof, in fully paid up shares, as to £2,000 in cash, and as to the remaining £18,000 by the issue to the promoters of 12,000 shares, having £1 10s. per share paid up. A negotiation ensued with reference to the surrender of these shares, and on the 30th October, 1883, an agreement was entered into between the said promoters of the one part, and the company of the other part, whereby in effect the whole of the said £70,000 has been agreed to be surrendered and repaid to the company in consideration of the promoters being released by the company from further liability in respect of calls on the above-mentioned 12,000 shares.

The promoters had paid a sum of about £6,000 in cash on account of a third call of 10s. per share upon the said 12,000 shares. They had also spent a considerable sum, amounting to several thousand pounds, in advertising and bringing out the company. In respect of these two last-mentioned payments the company have agreed to issue to them fully paid up shares amounting to £7,000. The net result of this arrangement with the promoters is that they have agreed to give back, in paper, or in account, the whole of the money which they received from the company, being allowed but £1,000 in account, for their preliminary expenses.

A large proportion of the purchase money paid to Messrs. Gülcher and Groth and to Mr. Wm. Crookes for their respective patents was paid in fully paid-up shares of the company, and the result of the above-mentioned arrangement with the promoters, if carried out independently, would have been to increase the ratio of their holdings to the holdings of the other shareholders, and consequently their share of any profits of the company would have been very largely increased. Upon this being represented to Messrs. Gülcher, Groth and Crookes, these gentlemen voluntarily agreed, in the event of the agreement with the promoters being ratified by the company, to surrender such proportions of their respective holdings as would place them, relatively to the other shareholders, in the same position as they would have held had that agreement not been entered into.

By this voluntary surrender the capital of the company will be further reduced by 3,770 fully paid-up shares of £5 each, amounting to £18,850.

The net result of the action of the investigation committee, if the shareholders confirm the first-mentioned agreement will be, that the purchase money paid by the company for their patents will be reduced from £135,000 to £46,150.

The Finance Committee.—In a circular issued to the shareholders on the 1st of October, 1883, the directors stated shortly the precarious position in which the financial affairs of the company then were. The committee discovered that there was a bill of sale for £11,000, extending over the whole available assets of the company. The fifth call which was payable on the 29th of October, and all arrears of call were mortgaged to one creditor, and the funds in hand and immediately forthcoming were insufficient to meet the pressing claims and the trade debts. A sum of £1,000 which appeared in the balance-sheet of the 30th June, as an asset proved to be a liability, an award respecting it having been made adversely to the company.

In order to provide this £1,000, and to discharge the trade and other debts, the directors made the sixth call upon the shareholders, and pending the receipt of this call they were obliged, in order to carry on the company's business at all, to pay their own calls in advance and to obtain the like advances from other shareholders. The funds obtained by these means enabled the finance committee to discharge the bill of sale and liberate the assets of the company, and with the aid of funds coming in from sales, to carry on the business and considerably reduce the debts.

The finance committee also discovered that by an agreement between Messrs. Ransome and the company, Messrs. Ransome were entitled to a commission of between 3 and 4 per cent. upon the whole turnover of the company for five years; this commission being for the loss of the benefit of a contract whereby Messrs. Ransome manufactured the company's dynamos and lamps. The finance committee represented to Messrs. Ransomes the intolerable character of the burden of such a commission, and also that the rent for the occupation of their factory at Battersea reserved by them (£600) was, in the opinion of the committee, excessive, and in the result Messrs. Ransomes agreed to give up the commission and to reduce their rent, as from Christmas last, to £400 per annum conditional upon the shareholders confirming the other agreements hereinbefore stated. The only return for these large concessions which Messrs. Ransomes have asked is that the company should give, and maintain for one year, installations for them at Battersea and Chelsea.

The terms upon which Mr. Crookes sold his patents to the Company included a provision that he should be appointed for five years consulting electrician to the company, at a salary of 500 guineas per annum. The finance committee pointed out to Mr. Crookes how heavily this condition was bearing upon the company in its infancy, and suggested some modification of it. In response to this suggestion Mr. Crookes has consented to continue his services as consulting electrician, and to postpone his fees until the same can be paid out of the profits which shall remain after declaration of a dividend.

Works Committee.—The manufacturing department has been thoroughly reorganized by the works committee. Proper store rooms have been constructed and a proper system arranged of issuing and checking the stores. Prime cost books have been introduced, and the whole system of factory bookkeeping has been re-organized. The company will in future be able to tell, which has hitherto been impossible, the exact profit upon every order received, and the exact price of each of the various articles manufactured.

After the most careful consideration the works committee have recommended the board to decline to undertake the lighting of a section of the City of London which was offered to the company. The committee have before them numerous offers of business but have hitherto refrained, as much as possible, from accepting any which involve supplying power. In all the cases above-mentioned, and in various other smaller installations, the power is supplied by the customer. In the case of lighting a section of the City, the company would have had to provide not only the power, but a site for the engines, and this has appeared to the committee conclusive against entertaining the offer.

Special attention is being paid by the works committee to the lighting of ships; and already two small trial orders have been given by Her Majesty's Government for the lighting of ships in the Royal Navy. The first installation at Portsmouth has been so far successful that a second order has been received, which, if equally satisfactory to the Government authorities, is to be forwarded to the *Minotaur* (the flag-ship of H.R.H. the Duke of Edinburgh) in the Mediterranean.

The company has lately been invited by the Admiralty to tender for other ships, and the works committee have now before them specifications for lighting no less than four.

A small installation at the Government School of Engineers at Chatham has given equal satisfaction to the Royal Engineer Officer in charge there.

An extraordinary general meeting of the company was held at the City Terminus Hotel on Wednesday afternoon, Mr. D. De Castro in the chair.

The Chairman said he took the chair at the last meeting, a month ago, in the absence of Professor Crookes, the chairman at that time, who was away in consequence of a severe affliction; and he (Mr. De Castro) now occupied the position of chairman of the company upon the nomination of Mr. Crookes, whose avocations were so numerous that he felt, in the present crisis, he could not give the time necessary to properly attend to the affairs of the company.

The Secretary, Mr. Russell Day, having read the notice convening the meeting,

The Chairman referred to the circular issued to the shareholders, a portion of which we give above, and said he might summarise a little more concisely the substance of the circular by saying that the investigation committee obtained from the promoters of the company the surrender of £70,000, part of the £100,000 purchase money paid for the patents, and they also obtained in consequence of that a further voluntary surrender by Messrs. Crookes, Gülcher & Groth of £19,050, so that from the purchase money £89,050 had been taken off. The result of the finance committee's labours was that they reduced the rent of the premises by £200 and induced the consulting electrician to postpone the annual fee to which he was entitled until the payment of a 5 per cent. dividend. The directors' fees, according to the articles, were £1,500; there was a managing director at £750, a secretary at £200, and a cashier at £150, making a total of £2,600: that would now be done for £1,400, so that, altogether, there would be a net saving of £1,200. The only increase was in the rent of the offices in the City; they found it simply impossible to carry on the business of the company and to have board meetings well attended at Battersea, and they hoped the City offices would prove of very great advantage in many ways. A further saving by means of the commission given up by Messrs. Ransome would be effected; and, to pay a dividend of 5 per cent. upon their reduced capital would take about £5,000, whereas to have paid it under the old circumstances would have involved a net profit of £15,000. Referring to the installation in Lyttleton Harbour, New Zealand, he said it had been obtained by them in supercession of the Brush Company, who had not given satisfaction, and against whom they had competed; this installation consisted of 14 or 15 2,300 candle-power lamps. The largest oil mills at Bermondsey were being lighted by the company, partly by arc and partly by incandescent lamps, and the work there had already borne fruit, inasmuch as they had now received invitations to tender for lighting other large factories in the same way. The most important of their 30 or 40 installations was that at the Crystal Palace, where they had already in progress 75 arc lamps, which was the largest installation of arc lighting in the world, and this was based on figures which would not only produce a profit, but must, having regard to the fact that there is to be an international exhibition at the Palace this year, save them any other advertisement, if the thing were only properly managed. With regard to the City of London lighting, he was requested to correct the statement in the circular that they had had an offer; it was not exactly an offer as no price was stated, but they were one of the two companies selected, after their systems had been examined, to tender for lighting a portion of the City. They declined to entertain the idea at present, but if they should become stronger and have funds they did not know what to do with, they might probably go in for it in future. It was more important that they should attempt that only which they could do easily; they could easily light mills where power was provided, and ships, where also power was available; and in both those directions there was an endless scope. The immediate business of the meeting was to consider the following resolution, which, if carried, would have to be confirmed at a subsequent general meeting:—"That the regulations of the company be altered by the addition of the following regulations:—*(a)* The directors may accept surrenders of shares on such terms as they think fit, provided that no part of the assets of the company representing paid-up capital be employed in the purchase of the company's own shares. *(b)* The directors may sell any surrendered shares and register the purchaser as the holder thereof, and may cancel any share acquired by surrender, and may (unless the company otherwise resolve) isssue new shares in lieu thereof." Before formally moving this, he would tell them what they proposed to do when the resolution was passed. If they confirmed the resolution at the next meeting, the board would move that the surrenders should take place in this way: that the capital be reduced from £300,000 in 60,000 shares at £5 each, to £150,000; such reduction to be effected by accepting the surrender of 11,000 fully paid up shares, and of 12,000 shares on which £1 10s. had been called, agreed to be surrendered by Messrs. Fox, Johnson & Garrett; that was the £70,000 which he had told them had been given up by the promoters. The next step was to accept the surrender of 2,050 fully-paid £5 shares, agreed to be surrendered by Mr. William Crookes, the 880 similar shares given up by Mr. Gülcher, and 880 by Mr. Groth. Then it was proposed, in order to reduce the capital to £150,000, to cancel 3,190 unissued shares of the company which had not been agreed to be taken up by any person; that would knock off another £15,000 or £16,000. But, as the circular stated, the number of shares to be so cancelled would have to be settled by the shareholders at the general meeting. Many appeared to be anxious to secure Stock Exchange quotations, and in that case 9,190 shares would have to be cancelled, representing £45,000 or £46,000, instead of £15,000. The chairman concluded by moving the resolution.

Major Cotton seconded, and the motion was carried with but one dissentient, Mr. Hadland, who protested against the course being adopted, remarking that he understood they were losing about £200 a week; and, in that case, they would have to wind up before long.

The Chairman contradicted this statement, and

Mr. Biggs, in moving a vote of thanks to the chairman, said he thought Mr. Hadland must have alluded to past experiences in suggesting that they were not making profits. He continued to speak with approval of the action of the chairman and the present board since they had taken office, and concluded by observing that the Crystal Palace installation was the best advertisement they could have.

Mr. Charlewood seconded the motion, and took the opportunity of asking the chairman to clear up a misunderstanding as to whether Mr. Crookes was giving up his salary altogether, or that payment of it was simply postponed.

The Chairman said Mr. Crookes was entitled to 500 guineas per year out of the capital. The board asked him to give that up altogether, but he said, "No, I cannot give it up; it is part of my purchase money: but I will take it out of the profits instead of capital, and if you are making profits you can't complain of paying me to help make them."

The motion for the vote of thanks was then put and carried unanimously.

The Chairman said before the meeting terminated he should like to add a few words as to what they proposed to do for the future. It was not to be wondered at that much money had been lost in connection with electric lighting, which had only quite recently "turned the corner," and established itself as a feasible and practical art. A few scientists three or four years ago knew how to produce electric light, but the best methods of its application had not been ascertained. Thousands of pounds were thrown into the laps of promoters of companies, who started with enormous capitals, but the people were not forthcoming who knew how to manufacture. The most energetic and enterprising trades nearest akin to electric lighting took it up, and almost till now nothing but experimenting had been done at the expense of those who had subscribed, foolishly expecting to get immediate dividends. This was the fault of the public, who threw so much money into electric lighting before it was ripe. He thought there was no doubt but that it had turned the corner, and the companies now understood what they had to do when an installation was offered them. The shareholders in this company had lost their cash to a great extent in the way he had described, and the question now was, how were they to go on? They wanted money, but in order to avoid making a further call the board proposed to issue at least £12,000 in six per cent. debentures. Nearly half of that sum would be subscribed by Mr. Crookes and the board, and they would ask as many of the shareholders as could afford to do so to assist in the same way, without appealing to the outside public.

Mr. Defries moved a vote of thanks to those who had given up their claims upon the company as stated in the circular and by the chairman.

Mr. Davidson seconded, and the motion was carried.

Major Cotton urged those shareholders who had not already done so to pay up the remainder of their calls as soon as possible.

The meeting then concluded.

Telegraph Construction and Maintenance Company.

SIR DANIEL GOOCH, Bart., M.P., presided last Tuesday at the 20th ordinary meeting of this company, which was held at 38, Old Broad Street.

Mr. W. Shuter, the Manager, having read the notice convening the meeting, and the minutes of the previous meetings,

The Chairman said he might congratulate the shareholders on the continued prosperity of the company. They had called the meeting to declare to the shareholders a dividend of 20 per cent., which he hoped would be satisfactory to them. Referring to report (which was published in the ELECTRICAL REVIEW of last week), he stated that the Brazilian Submarine Telegraph Company's cable between St. Vincent, Cape de Verds, and Pernambuco, Brazil, which was broken, in September, in the neighbourhood of the Equator, in a depth of 1,900 fathoms had been repaired, a length of about 80 miles of new cable having been spliced in. He might say that this was considered a remarkable feat, and that the officers of the company gained great credit in being able to accomplish the work. The new cable was laid in a very short time, and was very successfully done. The Brazilian Company were highly pleased at the manner in which the work was done. It was also satisfactory to know that that cable had been down 10 years, and when taken up was in a perfect state on each side of the fracture, being as bright almost as when new. The cause of the parting of the cable was the upheaval of the bottom of the sea from some subterranean action. The accounts would speak for themselves, but he would be glad to give any information of detail with regard to them which any shareholder might require. The chairman then moved the adoption of the report and accounts, which was seconded, and agreed to.

Mr. Lewis asked whether the chairman would inform the meeting of the manner in which the 6 per cent. debentures were allotted. (Hear, hear.) Considering that this company had cash in hand to the amount of £110,000 and a reserve fund of £50,000, it seemed rather strange and surprising that the company, having such a stand in the market, should have to pay 6 per cent. for their money. He thought it could be obtained for 5 per cent (A voice: "4 per cent.") Mr. Lewis thought perhaps at 4½ per cent. It was true he applied for some of these debentures, but he did not get any. But that did not affect the argument. In these days, when directors exercised so much secrecy and took upon themselves such arbitrariness, which was not allowed by any Government, if he might use the term, it would be considered impertinence on his part if he asked whether a list of persons who received allotments should be given, with the amount which each received.

A Shareholder asked whether the board expected to finish the laying of the Brazilian cable this year, to which the Chairman replied in the affirmative.

Mr. Croft observed that at the last half-yearly meeting, some of the shareholders made some remarks with regard to the electric lighting. He thought the chairman said, in reply to that, that the subject would not be lost sight of by the directors. Considering that electric lighting was now one of the great topics of the day, and he supposed there would be an end, sooner or later, to the laying of submarine cables. ("No, no," and laughter.) He hoped *not*, of course, in common with other shareholders; still there must be a limit sometime or other, and he should like to know whether the directors saw their way to utilising the resources of the company for the purposes of electric lighting.

Mr. Cooper thought Mr. Lewis had been too stringent in his remarks concerning the "secrecy" of the board, and he took objection to the language.

The Chairman said that with regard to the "alleged secrecy" of the board which a shareholder had referred to, the shareholders should rather judge by the results of the working of the company, and he thought they saw satisfactory results by receiving a dividend of 20 per cent. for the year, without going into *minutiæ*. He should not hold that chair for one hour if he knew that the shareholders were conducting the business of the company instead of the directors. These six per cent debentures were allotted amongst the shareholders of the company who were likely to hold them, and not to make a market speculation of them. (Hear, hear.) They had £150,000 to dispose of, and applications to the amount of £800,000. It would not be consistent with the duty of the board to print and publish a list of their debenture-holders, nor of any other part of their affairs. He would not be a party to publishing such a list. The directors acted on their responsibility in what they did, and if the shareholders could not trust them they should look for somebody else. The debentures were allotted amongst the large shareholders, as the applications so far exceeded the sum to dispose of, and, of course, amongst shareholders only. It was impossible for a man holding, say, three shares, to get hold of a lot of debentures. He believed, in fact, that one person with three shares *did* apply for £18,000 of debentures. With regard to the six per cent. paid for the money, he did not think that was too much to give for money in a company of the speculative character which this was. They gave six per cent. previously because they could not get the debentures taken up. With regard to electric lighting, they got what was *practically* a concession from Parliament to light a portion of St. James's, and that in connection with the Edison people. They got the power, and this company was to help them. But it was found that the Board of Trade was not able to agree to a division of the powers granted by Parliament, and therefore this company were in Parliament this session with a small bill to enable them to carry that arrangement out. He might say they were not losing sight of such work. But they must remember that the lighting of St. James's, or any other portion of London, was a very serious matter to undertake, because the board had no practical experience of that class of work. As an experiment, and for the sake of obtaining information, they had arranged with the Great Western Railway Company to light Paddington station all through. This would be a large extent of lighting, and he hoped would give them some useful information, at any rate. He hoped the work would be carried out before they met again.

Mr. J. Newton said that however much the board objected to criticism, he did not think it becoming of the board to assume the chairman bad, if the shareholders made any particular inquiry. He certainly very strongly objected to the chairman telling the shareholders that because they issued debentures at 6 per cent. 10 years ago, they issued them now at the same rate. Telegraph properties, which were then issuing debentures at 6 per cent., were now issuing them at 4 per cent. It was the bounden duty of the directors, whether they liked criticism or not, to get the money as cheaply as possible, because otherwise the big shareholders get all the plums and the smaller holders the crumbs. (Laughter.) He thought the credit of this company was so magnificent, that it would look more creditable if they were issued at 4 per cent.; the whole of the shareholders would then get the advantage.

Sir Daniel Gooch, Bart., M.P., and Sir Thomas Fairbairn, Bart., two retiring directors, were then re-elected, as were also the auditors, Messrs. Gane and Glegg, at a remuneration of £150 a-year each.

A vote of thanks to the chairman and directors closed the proceedings.

Anglo-American Brush Electric Light Corporation, Limited.

AT the City Terminus Hotel, on Wednesday, a special general meeting of this corporation was held for the purpose of confirming a resolution passed at the general meeting three weeks previously. Lord Thurlow presided.

The Secretary, Mr. Emile Garcke, having read the notice convening the meeting,

The Chairman said: It will not be necessary for me to detain you at any length this afternoon. You are all aware of the reason for which we have met here to-day; our meeting is simply formal and statutory to confirm the special resolution which you passed unanimously at the general meeting which was held at this hotel three weeks ago to-day. I think I may congratulate you all on the unanimity with which that resolution was passed, and has been received, both by the great body of shareholders themselves and by the public out of doors. It will be quite unnecessary for me to dwell at any length on it to-day. You fully understand its object, and I will now only ask you to confirm it, as it is necessary to do in order to conform to law. The resolution was as follows:—"That the capital of the corporation, which now consists of £800,000, divided into 80,000 shares of £10 each, of which 13,701 shares have been issued, and are fully paid, and 26,999 shares have been issued, and have £8 per share paid, or called up thereon, be reduced to £400,000, divided into 80,000 shares of £5 each, and that such reduction be effected by cancelling paid-up capital, which has been lost or is unrepresented by available assets, to the extent of £5 per share, upon each of the 40,700 shares which have been issued, and by reducing the nominal amount of all the unissued shares from £10 to £5."

Mr. J. S. Sellon seconded, and the resolution was carried unanimously.

Mr. Offor, in moving a vote of thanks to the chairman, remarked that he hoped that that meeting would be a model for all other electric light companies connected with the Brush system. The parent company had shown a wonderful example of unanimity existing between the board and the shareholders, and its children should not be slow to follow it.

Mr. Turnbull seconded the vote, which was heartily accorded. The Chairman having, in response, expressed the hope that the next time they met he hoped to have something to communicate to them, the meeting terminated.

The "Pilsen," "Joel," and General Electric Light Company, Limited.

THE following circular, dated Feb. 26th, has been issued to the shareholders by order of the board of the above company:—

"A large body of the holders of partly paid-up shares, who had formed the opinion that the interests of the holders of the fully paid-up shares are in conflict with the interests of the other shareholders, recently appointed a committee to confer with the directors and with the vendors, and to take such steps as appeared necessary for reconciling these with advantage to both parties.

"The scheme of the committee, submitted to the directors, embraces a surrender of the fully paid-up shares at less than a fourth of their nominal value, together with a proposal for the reduction of the other paid-up capital of the company, and of £1 per share in the amount of liability for calls.

"The details of the scheme having been carefully considered by the directors, they are of opinion that it is decidedly advantageous for all classes of the shareholders, and they therefore recommend the shareholders to adopt it at the meeting of which notice is enclosed, and to pass the resolutions accompanying the notice which have been framed for carrying out the scheme. Proxies are enclosed to enable shareholders who cannot attend the meeting to record their votes in favour of the scheme.

"The committee's circular on the subject, which has been submitted to the directors, and sent to you, explains the grounds on which the committee have proceeded, and the directors have pleasure in acknowledging the satisfactory results arrived at."

The resolutions named above are:—

"1. That, notwithstanding anything contained in the articles of association, the directors be authorised, and are hereby directed, to carry out the following compromise and modification of the agreement with the vendors, the Union Electric light and Power Company, Limited, that is to say,—That the directors shall take a surrender of the 11,530 fully paid-up £5 vendors' shares, which were allotted to the Union Electric Light and Power Company, Limited, in consideration of the purchase, and of such of the 470 like shares allotted to their nominees as can be obtained, and that the directors do pay, in lieu and consideration thereof, a sum not exceeding the amount of £1 3s. 4d. for each of such shares, and that, as hereby modified, the said agreement with the vendors be confirmed.

"2. That if an order of the Court be obtained for confirming this resolution, the capital of the company be reduced as follows:—(1) By cancelling the 12,000 fully paid-up vendors' shares as and when the same shall be surrendered pursuant to the foregoing resolution, or such of the said shares as shall be so surrendered. (2) By cancelling the sum of £1 per share on the 28,000 shares in the company with £2 10s. 0d. called up thereon, and also on any fully paid-up vendors' shares which may not be so surrendered as aforesaid, as being capital which has been lost, or is unrepresented by available assets. (3) By reducing the amount liable to be called up on the 28,000 shares with £2 10s. 0d. called up thereon from the sum of £2 10s. 0d. per share to £1 10s. 0d. And that the memorandum of association of the company be modified so as to carry into effect this resolution.

"3. That the directors be authorised to pay the costs and expenses, amounting to £55, incurred by the committee of shareholders up to the 5th February, 1884, when their scheme was submitted to the directors, as well as such further costs and expenses as have been, or, if the scheme of the committee be adopted by the company, may hereafter be incurred in reference to such scheme."

Calls.—The Edison and Swan United Electric Light Company having made a call of 10s. per share, the Swan United Electric Light Company has made a similar call to enable them to meet this contribution, and also to provide funds for their foreign business.

Great Northern Telegraph Company.—A telegraph station has been opened at Wuhu, China. The rate to Wuhu from all stations in the United Kingdom is 9s. 8d. per word.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company. Limited. The estimated receipts for the half-month ended the 15th February, are £2,967, as compared with £3,368 in the corresponding period of 1883. The November receipts, estimated at £4,563, realized £4,671.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 22nd, were £2,720, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended 22nd ult., amounted to £3,514.

NEW PATENTS—1884.

3639. "Galvanic cells." S. H. EMMENS, O. MARCH, United Patents Corporation. Dated February 20.

3666. "Electric log and revolution indicator." P. and A. T. H. SCOTT. Dated February 20.

3668. "Method of giving an individual call to any one of a group of subscribers connected to a telephone exchange by one wire." G. STEPHEN. Dated February 21.

3669. Giving fire alarms by electric current." J. STEPHEN. Dated February 21.

3704. "Electric arc lamps." H. J. HADDAN. (Communicated by E. Boettcher.) Dated February 21.

3714. "Apparatus for the transmission of sounds or articulate speech." J. K. D. MACKENZIE. Dated February 21.

3770. "Electric couple for producing electricity." G. PRZIBRAM. Dated February 22.

3782. "Galvanic batteries." T. ROWAN. Dated February 22.

3796. "Trucks and locomotives for telpher lines." F. JENKIN. Dated Feb. 22.

3797. "Belt for administering electricity for medical purposes." J. E. SPRATT. Dated February 22.

3835. "Telephones." G. W. VON NAWROCKI. (Communicated by A. J. W. Münch.) Dated February 23.

3847. "Casings for electric wires laid in foot-walks and streets." A. M. CLARK. (Communicated by R. Wylie.) Dated February 23.

3881. "Apparatus for registering a ship's course by electricity; applicable also to other sensitive and scientific instruments." J. H. BARRY. Dated February 25.

3884. "Carbon electrodes for electrolytical purposes." H. LIEPMANN. Dated February 25.

3885. "Electric arc lamps." W. GEIPEL. Dated February 25.

3901. "Electric arc lamps." F. THORNTON, O. ROMANZE. Dated February 25.

3952. "Discharging fire arms by electricity, and manufacture of cartridges." J. ANDREWS. Dated February 26.

3970. "Electric light arc lamp." H. F. JOEL. Dated February 26.

3980. "Circuit closers for telegraphic keys." J. NEIFING. Dated February 26. (*Complete.*)

3981. "Sensitive electric fuzes and detonators, and explosive compound (priming material employed therein)." F. WARD. Dated February 26.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

2675. "Electrical meters, &c." T. J. HANDFORD. (Communicated from abroad by T. A. Edison of America.) Dated May 30. 6d. Has for its object principally to produce a cheap and reliable meter for measuring automatically the electric current or energy consumed in a system for the general distribution of electricity for light, heat, and power; and incidentally to produce an electro-dynamic motor, suitable for this purpose, which motor may however be put to other uses.

2722. "Electric devices for indicating speed, and for operating safety valves." R. P. SELLON. Dated May 31. 6d. Relates to means and devices for obtaining indications of speeds of motors such as steam or gas engines, dynamos, or other sources of power, or for indicating reversals, of or variation in the speed of such motors by electricity, thus enabling one or more recording indicators to be placed at any distance from the source of power, all such appliances showing the speed of, or any variation in the speed of such motors in any desired locality, however far removed from the said source of power or from each other. The invention further relates to automatic electric safety valves, forming either a distinct apparatus independent of the ordinary safety valve applied to engines or other motors, or an attachment actuating the said ordinary safety valve, in case this should not come into action when the pressure, at which it may be set to open, is obtained.

2739. "Apparatus for generating and utilising electric energy." A. J. BOULT. (A communication from B. Faquant, of America.) Dated June 1. 4d. The object of this invention is the construction of a motor, which shall be automatic in its operation; in other words, so constructed that being once set in motion it will generate or cause to be generated sufficient electric force to keep the machine in motion and supply power and electricity for other purposes. The invention consists in the novel construction and arrangement of the parts whereby the power is generated stored, and conveyed to the working parts, and whereby the machine is rendered automatic in its operation, and in the various details for controlling the several parts. (*Provisional only.*)

2741. "Electro-magnetic engines, electro-motors, or electro-generators." R. W. M. **Fraser**. (Communicated from abroad by J. R. Fraser, of Gibraltar.) Dated June 1. 6d. Consists of two Siemens or other armatures, having their centres of rotation in the same straight line or in any other position, and revolving together, their magnetic faces being set at suitable angles to each other. These armatures are partly encircled by field-magnets, having their poles concentric with the faces of the armatures, and about the same size as the faces of the armatures. The current passes into these armatures and through their field-magnets alternately. The current passes through the field-magnets and armatures only at the time when the armatures and magnets will attract each other. This is effected by cutting the current off when it would cause the armatures to be repelled by the magnets. This current, which is cut off one set, is sent through the other, which is at attraction, thus greatly increasing the current in that armatnre, and thereby materially increasing the power.

2743. "Mechanism for regulating electric arc lamps." F. L. **Willard**. Dated June 2. 6d. The top or positive carbon is fixed to a rack which passes through the top platform of the lamp into which is geared in any suitable manner a small pinion, on the end of which is fixed a small click wheel or wheels, the click is fixed to the escapement wheel or wheels which are fixed on the click wheel before mentioned, into the escapement wheel works a pallet or pallets, on to the arm of which is fixed a small iron weight or armature; now if the rack before mentioned were pushed up the pinion alone would turn upon releasing the rack, the click before mentioned would prevent the rack from descending without revolving the escapement wheel before mentioned which would cause the pallet to vibrate, which would continue till the carbons touched. Now to prevent this, the inventor fixes a coil or electro-magnet in such a manner that the weight or armature before mentioned is attracted, so preventing any vibration when a current is passing through the coil. One end of the wire of the coil is connected to the positive terminal, the other to a contact screw of a small relay, which is wound as a shunt-coil of high resistance, the armature of which makes contact with the screw before mentioned to the base of the lamp. From the positive terminal a wire offering a resistance is led direct to positive carbon. To relight the arc should it be broken, the inventor fixes a small solenoid or electro-magnet, which upon a current passing through draws down the negative carbon, thereby forming the arc.

2763. "Apparatus for generating, distributing, regulating, and measuring electricity, &c." W. H. **Scott**. Dated June 4. 2d. The principle of the construction of the generating apparatus is based on the fact that if a conductor be made to rotate in an interrupted field, that is one in which the lines of force are concentrated in certain parts, so that the conductor is continually moving in and out of fields of different intensities, all the lines of force being in the same direction, a current will be induced in a constant direction. *(Provisional only.)*

2768. "Apparatus for generating electric currents, &c." H. H. **Lake**. (Communicated from abroad by R. E. Ball, of America.) Dated June 4. 6d. Relates principally to dynamo-electrical generators, and has for its primary object to mechanically simplify the same; to reduce the amount of copper used in their construction; to obtain increased efficiency in working effect; and to augment their electrical capacity.

2769. "Electric lamps, &c." W. R. **Lake**. (Communicated from abroad by C. L. R. E. Menges, of the Hague.) Dated June 4. 1s. 6d. This invention relates to electric lamps or lighting apparatus, and comprises the employment of two carbon pencils which are kept in contact under constant pressure, and put in communication with a source of electricity. The said invention also relates to apparatus to be used in the manufacture of the said lamps.

2770. "Electro-motors." J. **Imray**. (Communicated from abroad by H. T. Hillischer of Vienna.) Dated June 4. 2d. The object of this invention is to improve the construction of electro-motors so that their dimensions and the space occupied by them may be as small, and yet the power evolved by them as great as possible, and also to adapt them for driving rotary hand-tools. *(Provisional only.)*

2782. "Electrical wire protectors." J. O. **Cottrell**. Dated June 5. 6d. In one form of the invention, the inventor employs two parts or analogous pieces of cheap and non-conducting material, one lying upon the other against the wall of the apartment or against the ceiling, or wherever the wires are to be led along, and he forms grooves on the outer face of the piece which lies next to the wall or ceiling. This piece may be fastened to the wall in advance of the application of the wires; then the wires are laid in the several grooves and temporarily held by any convenient means.

2786. "Electrical apparatus for igniting gas, &c." J. A. **Koerber**. Dated June 5. 2d. Relates primarily to a portable apparatus for igniting gas by means of electricity. The apparatus consists of a zinc vessel containing, by preference, a battery of the agglomerate type. The vessel is charged with the usual exciting liquid, such as a solution of sal ammoniac, and is securely closed at the top by a lid. The carbon pole of the battery extends to within a short distance of the lid or a projection beneath same; and immediately above the said carbon is a spring-mounted contact-plate, capable of being pressed, by means of a thumb-knob, into contret with the carbon. The contact plate communicates with a wire or other conductor mounted above the lid of the main vessel. This conductor is enclosed within, but insulated from, a metal tube, or other envelope of conducting material, also mounted on the lid of the vessel. At the upper end of the tube communication is made, by means of a fine platinum wire, between the enclosed conductor and the body of the tube. On the thumb-knob being pressed and contact established between the carbon and the upper conductor, the circuit is completed and the platinum wire is raised to a temperature sufficient to ignite hydrogen gas. *(Provisional only.)*

2788. "Primary voltaic batteries." G. G. André. Dated June 5. 6d. The inventor employs a soluble carbonate, such as carbonate of soda in combination with a sulphate, such as sulphate of copper in one and the same cell which contains the copper or other negative electrode. The zinc or other positive electrode is contained in a saline, or it might be an acid or a saline and acid solution. A saline solution consisting of sulphate of zinc and sulphate of soda is suitable for the purpose. The negative electrode with its combined solution is contained in a porous cell or cells which may be placed in the container for the solution surrounding the positive electrode. The porous cell may advantageously be made of brown paper between an outer and inner layer of parchment paper on a wooden or other suitable framework.

2795. "Electric bell apparatus." W. R. **Lake**. (Communicated from abroad by La Société Dany et Lepage, of Paris.) Dated June 5. 4d. Relates to electric bell apparatus, the distinctive feature of which is the combination in a single apparatus of batteries, bell, and all the necessary electric conductors.

2800. "Electrical motor." W. **Peek**. Dated June 5. 2d. The object of this invention is to obtain rotary motion from an arrangement of electro-magnets, by actual contact of the magnets, with a minimum amount of friction. To effect this a disc of brass or other suitable material, or a series of radial arms, with or without a rim, is to be fitted to or cast with a central boss of steel or other hard metal, which may be either spherical or hemispherical in shape. On the disc, rim, or radial arms, electro-magnets are fastened in such positions that when energised by an electric current they shall attract or be attracted by iron or corresponding magnets or solenoids arranged on a fixed frame in juxtaposition to them. *(Provisional only.)*

2817. "Electrical signalling and interlocking apparatus for railways." C. **Hodgson**. Dated June 6. 8d. Relates to means of rendering the ordinary needle telegraph instruments available for interlocking with and controlling the point and signal levers, and to arrangements for simplifying the operation of levers electrically controlled from a distance.

2822. "Apparatus for putting instruments connected with a central telephone station into communication with each other." W. R. **Lake**. (Communicated from abroad by G. A. Cardwell, of America.) Dated June 6. 6d. Relates to telephonic apparatus, and has for its object to provide means whereby in a system of individual telephone lines, the several subscribers themselves may at will, through the intervention of a central office, connect their respective lines with the lines of others, and communicate with such other subscribers, without the assistance of operators at the central office, and so that such communicating lines may be private, and confined to two subscribers, or subject to connection by others, as desired, at the time.

2832. "Apparatus for connecting and disconnecting electrical circuits, and limiting and measuring currents passing through them." H. H. **Cunynghame**, O. E. **Woodhouse**, and F. L. **Rawson**. Dated June 7. 8d. Relates to apparatus whereby electrical circuits are connected and disconnected by hand, or automatically according to the strength of current, that strength being limited by the adjustment of the apparatus, and measured by additional apparatus which may be used separately.

2855. "Electrodes used as earth plates." D. G. **Fitz-Gerald**. Dated June 7. 4d. Relates to circuits for the production of electric illumination or the transmission of energy, or generally to circuits in which currents of electricity of several or many ampères are transmitted, and in which the earth is used as portion of the circuit. In ordinary telegraphic circuits, where the current is but a small fraction of an ampère, and is, moreover, frequently reversed, it has been found that gas or water pipes, or small plates of metal in contact with moist soil which is itself in contact with the great mass of terrestrial water, may very conveniently be used for the earth connections. But when continuous currents of great magnitude are to be transmitted through earth, the amount of electro-chemical action at the anode is sufficient to produce in course of time a detrimental amount of oxidation in iron or lead pipes, and rapidly to destroy a small plate of metal; whilst the large quantities of hydrogen gas evolved at the cathode lead to variations in the resistance of the circuit, and to consequent irregularity in the current, accompanied with a considerable loss of energy. To obviate these objections, and to secure regularity and economy in the working of circuits of which the earth forms part, and in which currents of comparatively great magnitude are transmitted, the inventor constructs the anode earth-plate of a readily-oxidisable metal, or of a conductor such as carbon (or any suitable metal) surrounded with a considerable mass of readily oxidisable material, such as lead or iron, in a porous or finely-divided condition; and he constructs the cathode earth-plate of a conductor, such as carbon or lead, surrounded with a considerable mass of oxidising material, such as plumbic peroxide, or of other material capable of absorbing or effecting a chemical combination with hydrogen. The anode and cathode thus constructed constitute un-polarisable earth plates.

2856. "Electrical generators and motors." W. R. Lake. (Communicated from abroad by Mary Bollmann, of Vienna.) Dated June 7. 4d. Relates to improvements in dynamo-electric and electro-dynamic machines. The dynamo-electric machines now generally used produce, by the inductive actions of galvanic, or magneto electrical currents, secondary currents, which by suitable mechanism are collected and commutated as direct currents. According to the present invention, secondary currents are also produced; but they are not commutated and carried off for use, but only used for exciting in the conductor of the inducing main current induction currents of the second order (tertiary currents) of the same direction as the main current, which is thereby strengthened. *(Provisional only.)*

2895. "Production of light by electricity and apparatus therefor." W. P. Thompson. (A communication from R. J. Sheehy, of America.) Dated June 9. 6d. Relates to arc electric lights, and particularly relates to certain appliances, by which the electrodes are maintained in that relation to each other which is essential to the production of a uniform and maximum degree of illumination, and to certain devices associated with each regulating mechanism, in order that a number of lights may be economically and practically operated at once upon a single circuit.

CORRESPONDENCE.

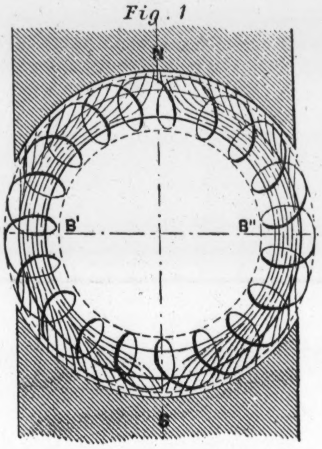
The Theory of the Gramme Machine.

The few remarks I made on the above in your issue of the 2nd inst., I now endorse, notwithstanding my having been confronted in the interim with what your correspondents evidently regard as the concensus of scientific opinion on this subject. When a question of importance is being argued *pro* and *con* in a scientific journal, it is, I think, the duty of one who holds adverse opinions to understand as much as possible the position of an opponent, however clumsily the latter individual may have strung his sentences together, but from the tone of Mr. Heinrichs' last letter, more characterised by notes of exclamation and interrogation than by close reasoning, it would appear that this desirable end had not been much sought after.

Setting aside Mr. Heinrichs' taunts regarding my too much thinking—a sin, by the way, of which the inventors of dynamos have been generally guiltless—I proceed to answer the various points raised in his letter of the 9th inst.

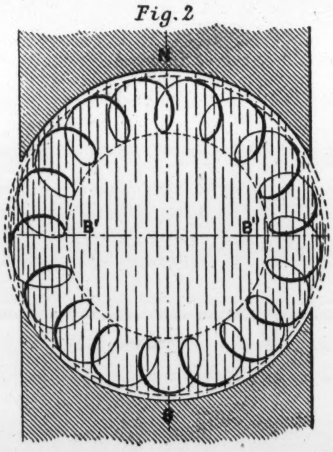
Fig. 1 shows the direction the lines of force take in a Gramme machine with an iron core. Fig. 2 shows the direction the lines of force take when there is no iron core. It will be seen that in fig. 1 none of the lines of force go through the centre of the ring—a result secured by having the ring of sufficient sectional area—while in fig. 2 the lines pass across almost straightly from pole to pole. In fig. 1 the iron core not only strengthens the field, but brings all the lines of force, created by the field magnets, within itself, so that each coil encloses all the lines of force passing through one side of the ring, twice in every revolution, at positions, B′ and B″. In fig. 2 the maximum number of lines of force, which a coil can enclose at B′ and B″, is very small, the majority of them going through the centre of the ring, as shown. I have supposed the brushes to be placed at B′ and B″ for simplicity. Neglecting the modification introduced by the field, due to the armature itself, which ought to be small in a well designed dynamo, we may assume that every coil encloses the maximum number of lines of force as it passes the brushes, and since the lines of force enclosed by the coil are *nil* when the coil is at N and S, it follows that the E.M.F., for any given speed, is simply proportional to the lines of force passing through the ring, or enclosed by the coils, at the brushes. When there is no iron core in the armature, as in fig. 2, the E.M.F. is small, because the number of lines of force passing through the coils, at the brushes, is small, and the machine works better with the iron core, for the simple but apparently overlooked reason that the core gives to the lines of force the direction they ought to have to be of service, and pulls them inside the coils. If the core is of insufficient area part of the lines of force go straggling through the centre of the ring, and we have the E.M.F. of the machine reduced, because the aggregate change per revolution in the number of lines of force enclosed by the coils is reduced, and the efficiency of the machine diminished, because we are creating a field which we do not utilise.

Fig. 1



The expression, "a wire cutting lines of force," conveys no meaning to my mind; the phrase, "*a conductor enclosing lines of force*," does convey a distinct meaning, and my contention is that the wire outside the Gramme ring cannot be considered apart from the wire inside the ring; the inside and outside wires form the complete coil, and the E.M.F. developed in that coil depends upon the rate of change in the number of lines of force enclosed by it, and on that only.

Fig. 2



Mr. Heinrichs recommends me to read the elucidations of eminent authorities. My opinion is that more nonsense has been talked about the Gramme machine, by eminent authorities, than about any other electrical subject, and the quotation Mr. Heinrichs gives in his letter is but a mild type of their many incoherent utterances. Besides, I do not require to read elucidations about matters which I can easily elucidate for myself, and when these elucidations enable Mr. Heinrichs give your readers an expression for the E.M.F. developed in a Gramme ring, having no iron core, which will negative the theory I have brought forward, I will then allow that there may be some reason in their statements. Mr. Heinrichs' own theory does not only want elucidating, but the premises upon which he bases it require some demonstration.

A few words in reply to Mr. Mordey will form a fitting conclusion to a contribution already too lengthy. Mr. Mordey refers me to an article in "Electric Illumination" for explanation regarding *idle* wire on machines. In perusing that article, some time ago, it did not strike me that there was anything specially clever in regarding dynamo machines from an electromotor point of view, especially, when it is remembered that, in a motor we seek to obtain conditions which we endeavour, as much as possible, to avoid in a dynamo. In a motor the field produced by the armature should be comparable with that produced by the field magnets, and I have yet to learn that the wire inside the ring in a motor does not contribute as much to the magnetising of the ring as does the outside wire. At any rate, be this as it may, the article referred to has not enabled Mr. Mordey to give a very satisfactory answer to the question which I proposed a few weeks ago, unless the "disinclination to reply to an anonymous correspondent" stands in the way. "In reply to the question as to which will have the higher E.M.F., a machine having its greater dimension parallel to the spindle or one in which the greater dimension is perpendicular to the spindle; the masses of iron, winding, &c., being alike in the two machines, I need only say," remarks Mr. Mordey, "that the latter construction is the best; if for nothing else, for the reason that one effect of the encircling poles is to diminish the resistance of the magnetic circuit." The *if for nothing else* in the above sentence leads me to infer that Mr. Mordey knows of nothing else; and if this be so, the circumstance is a remarkable one. Here is a machine, the ring armature of which is encircled by pole pieces, having consequently *no idle wire*, and yet we have nothing of the extraordinary advantages which were to have been obtained by bringing the whole surface of the wire under the influence of the magnets. The machine has now more than twice the amount of *electromotorically active* wire, as the learned Dr. St. Doubrava has it in his incomprehensible report, and yet Mr. Mordey admits that there is nothing to show for this save an advantage which was very properly characterised by M. de Wolffers, some weeks ago, as microscopical.

E.

The Efficiency of the Heinrichs Dynamo.

I have neither the time nor the inclination to discuss this subject further, but in justice to myself I would ask permission to state that the words "*total* efficiency" had not been employed by me in either of my letters, although Mr. Heinrichs insists on putting those words into my mouth. I should have thought that the meaning I attached to efficiency, viz., the value of the expression $\frac{R}{R + r}$ would have been conspicuous to most minds. Mr. Heinrichs, in a sentence remarkable for the splendour of its metaphor, remarks that I am still in the chrysalis state. Mr. Heinrichs here pays me a high compliment. It is gratifying to think that I have passed the stage of grub, a form somewhat persistent in the domain of electric lighting. But in the words of the song, "I'd be a butterfly."

One word more. I fail to see how any facts which I may place before your readers are modified by my withholding my name. The truth is equally valuable signed or unsigned, and while writing under a *nom de plume* my object is to discuss principles, not the demerits of their particular exponents.

I further endeavour to avoid those rude inuendos which form so large a part of Mr. Heinrichs' stock-in-trade, and to which, when employed as arguments, your readers will doubtless be able to attach a true value.

E.

[As our correspondent does not, in any way, re-open the discussion on the Heinrichs machine, we think his request for the insertion of the above communication a reasonable one.—EDS. ELEC. REV.]

Bell's Telephone Patents in England.

I do not clearly understand the point of Mr. T. J. Handford's remarks on my letter in the REVIEW of 16th inst. In the first place, Mr. Handford says that I imply "that under no circumstances could the avoidance of a foreign patent affect the validity of a patent granted in Great Britain for the same invention."

I take leave to say that my language does not admit of any such a meaning.

I seldom permit myself to express an opinion on any point of law without having consulted the books thereon, and the section 25 of the Patent Law Amendment Act of 1852 was known by me. Under that law a British patent for an invention for which Letters Patent had been previously obtained in a foreign country would cease and be void after the expiration of the term of the foreign patent; but the case is entirely different when the foreign patent has been declared void by a judicial decision or has become forfeited by non-compliance with the laws of the foreign country.

In the United States a patent can be annulled by a competent tribunal because of a prior invention in any part of the world. I submit that in such a case the British patent for the same invention would not become void; nor would a court annul the British patent, otherwise the court would decide against the well-established law that a prior publication to affect the validity of a British patent must be a publication within the United Kingdom.

Again, in some countries, like to England, the failure to pay taxes at stated times on the patent annuls the patent; can it be held under the Act of 1852, that an English patent would be annulled because of the expiration of the foreign patent in consequence of the failure to pay the taxes there?

I hold it to be good law, under the act of 1852, that a decision in a foreign country, avoiding a patent granted there, could not in any way impair the validity of an English patent obtained subsequent to the foreign patent.

The New Patent Law has, however, placed English patents independent as to duration of any foreign patent.

The patent laws of the United States differ in three great points from the English law:—

1. The applicant for a patent must swear that he is the first inventor.
2. A prior publication of a similar invention in any part of the world will render the patent void.
3. The expiration of a prior foreign patent for the same invention, from whatever cause (failure to pay taxes, or, as in France, importation of the patented article), renders a patent void.

I am pleased to learn that the U. S. Commissioner of Patents has recommended to Congress to limit the duration of the term of the U.S. patent to the term for which the prior patent was obtained in the foreign country.

W. C. Barney.

Feb. 25th, 1883.

I was much interested in Mr. Handford's letter in last week's REVIEW on the above subject, as I and many others were under the impression that the new Patent Laws did *not* affect patents taken out prior to December 31st last. From Mr. Handford's letter, I gather that not only do the Bell and Edison patents come under the full effect of the new act, but that *all* patents do so, and I further gather, then, if the owners of the Bell patent are entitled to the *privilege* of still retaining this patent in force in England, even should it be declared null and void in America, which seems exceedingly probable, then they must also be subject to the *disadvantages* of the new act, and under its provisions *may be compelled by the Board of Trade to grant licenses for the manufacture and sale* of their instruments on reasonable terms?

I should like to ask Mr. Handford if this be so; and also if it really be the fact that but for the new act the Bell patent would have been null and void in England, if it be now declared so in America?

Receptor.

February 26th, 1884.

The First Inventors of the Telephone.

In my communication published in the REVIEW on 23rd inst., I gave a list in chronological order of seven claimants to the honour of being the original first inventor of the telephone.

The name of Antonio Meucci stands at the head of the list, for whom it is claimed that his invention dates back to 1849, as testified to by many disinterested parties. The first official record of any such invention by Meucci, is the caveat filed by him in 1871 in the U.S. Patent Office, and the first public printed notice of his claim "to transmit accurate speech," which I have as yet been able to find, is in the *Commercio di Geneva* of 1st December, 1865. From this newspaper article I condense the following statement :—

"Several articles giving an account of Manzetti's claims to have discovered 'the transmission of sound and of speech by the telegraph' having been republished in the United States, notably in the *Echo d'Italia*, of 19th August, 1865, a certain Mr. A. Meucci wrote to the *Il Commercio di Geneva* a letter dated Clifton, Staten Island, 29th August, 1865, in which he claims priority of the invention of Mr. Manzetti. According to his statement, before 1860 he had discovered that by means of a small instrument placed in the ear and acted upon by electricity through a metallic wire, he could transmit accurately speech by holding one end of the wire between his teeth. By this method, two persons at a distance from each other could hold communication together. He adds that he disclosed his discovery, in 1860, to a Mr. Bendetari, one of his friends, who was about to start for Italy. In 1865, Mr. Meucci, having heard of the results obtained by Mr. Manzetti, wrote to Mr. Bendetari to inquire whether Mr. Manzetti had not been informed of his (Meucci's) communication to Mr. Bendetari before his departure from America. To this Mr. Bendetari replied that he had not disclosed to anyone the discovery of Meucci, of which he well remembered to have been informed in the house of Mr. Reveccio at New York."

In regard to the principles of the action of Meucci's telephone I have been unable to find any definite description, which, however, will shortly be made known by the publication of the patent he has applied for in the United States under the caveat of 1871.

In the *Diritto* of 21st December, 1865, I find a defence by the editor of what he called the rights of Mr. Manzetti, from which I make a few extracts.

"The idea of Mr. Manzetti, which differs greatly from that of Mr. Meucci, originated in 1854, according to the evidence of many persons. It was the construction of his automatic flute player which suggested the idea. At this time Manzetti was making experiments on sound waves and their mode of propagation, and he conceived the idea of adding to his automaton a mechanism by which it could be made to speak as well as play tunes. At this time he made numerous experiments and obtained articulate sounds. He then devoted himself to the study of the transmission of speech, and he succeeded in obtaining a reproduction not only of melodies, but also the direct transmission of speech ; thus he accomplished the development of his first idea of 1854."

"By means of this telegraph, he who speaks can be heard simultaneously at the end of as many telegraph wires as are connected to his instrument."

In a communication by me, published in the REVIEW of 7th January, 1882, I gave a list, as follows, of the newspapers in which mention was made of Manzetti's invention :—*Il Diritto*, 10th July, 1865 ; *l'Italia a Florence*, 10th August, 1865 ; *l'Echo d'Italia*, of New York, 19th August, 1865 ; *Il Commercio d'Italia*, of Genoa, December 1st, 1865 ; *La Verita di Norcau*, 4th January, 1866 ; *Il Commercio di Geneva*, of 6th January, 1866 ; *La Feuille d'Aorti*, in various numbers, 1865-66 ; *La Petit Journal*, of Paris, 22nd November, 1865.

In *La Feuille d'Aorti*, of 25th July, 1865, I find the following notice of Manzetti's invention :—"Mr. Manzetti transmits speech by means of a telegraph wire with an apparatus more simple than that now used on the telegraph wires, and henceforth two merchants can transact their business between London and Calcutta. The possibility of transmitting by means of electricity the vibrations of sound undulations produced by the voice is clearly demonstrated." In the same newspaper of the 22nd August, 1865, I find the following :—"It is said that English engineers, to whom Manzetti communicated his method of transmitting speech by the telegraph wire, proposed to apply his invention to private telegraph wires used in England."

Perhaps those English engineers, if they be yet amongst us, will give to the public what they then learned of Manzetti's invention.

Le Petit Journal, of Paris, of 22nd November, 1865, contained an article by an avocat of the Imperial Bank of Paris, headed, "Discovery of the Transmission of Sound and of Speech by the Telegraph, by Manzetti." I have been unable, as yet, to find any description of the mechanism or method used by Manzetti for the transmission of speech. From the publication above referred to, it appears that Manzetti conceived his idea of the transmission of speech by electricity in 1854, and it was publicly announced in 1865 that he had actually accomplished the result which "has been the admiration of the whole world." But, alas! how he did it lies with him, a secret, in the grave.

The first publication (so far as I have yet discovered) of any description in detail of any system of transmitting speech by means of electricity was in a journal, *l'Illustration*, of 30th July, 1854, Paris, and subsequently in the *Didaskalia*, of Frankfort, 28th Sept., 1854. This was an invention of Charles Bourseul, a Frenchman, and about that time a soldier in the army in Algiers. That description is as follows, and it will be seen that it fully describes the system and the means used :—

"An electric current passing through a wire transforms a piece of soft iron into a magnet. If the current ceases the magnetism also ceases. This electromagnet can be made to alternately attract and release a movable plate, which in its to and fro movements produces the conventional telegraphic signals. Now, it is also known that all sounds which reach our ear are produced by vibrations in the air, and that the infinite variety of sounds depends solely on the speed and magnitude of these sound waves. If, now, a metal disc could be invented which would be flexible enough to reproduce all the sound waves transmitted to it by the air, and if that disc could be connected to an electric circuit—such a way that in conformity with the vibration of the air it would start and interrupt the current—then it would also be possible to cause a similarly constructed metal disc, in electrical connection with the first, to repeat all the movements of it, and the effect would be the same as if one had spoken directly against this second disc—that is to say, the ear would be affected in the same manner as if it heard the speech directly through the first metal diaphragm."

I have thus far been unable to discover whether Bourseul ever made an instrument after the above description ; but the fact that Philip Reis was the *first to make*, and *give to the public a speaking telephone*, is clearly established by the numerous publications cited by Professor Silvanus P. Thompson, in his book, "Philipp Reis, Inventor of the Telephone." Instruments made by Reis himself were sold in 1861. That Reis's instruments, made according to the description of them, will transmit speech can be verified by anyone. I have frequently heard them talk. Mr. Justice Fry, in his judgment, said, "I have some evidence that they will transmit articulate speech."

In the last article on the invention of the telephone written by the late much-lamented eminent savant, Count Du Moncel, in *La Lumière Electrique*, of 29th October, 1883, appear these words: "Ou a entendu certaines paroles dans la telephone de Reis."

I avail myself of this occasion to express my deep sorrow for the death of this eminent man of science. For fifteen years past I have had the pleasure, when in

Paris, of enjoying his society, and learning from his lips many important scientific facts, and of receiving advice in many electrical matters; and when absent I have derived much valued information from our correspondence. He was a man of deep study, indefatigable in his researches after the truths of science, of high tone, great amiability, and unbounded benevolence; to know him was to love him.

W. C. Barney.

Feb. 25th, 1884.

The Distribution of Electricity.

The following correspondence has passed on the subject of Messrs. Gaulard and Gibbs' system of electric lighting by induction coils, between Messrs. Gaulard and Gibbs and Sir Charles Bright, the English president of the Société Internationale des Electriciens:—

"18, Warwick Street, Regent Street, W.,
"London, 18*th Feb.*, 1884.

"*To the President of the English Section of the International Society of Electricians.*

"Sir—At its meeting of the 6th instant, the International Society of Electricians had on its list of subjects for discussion, Messrs. Gaulard and Gibbs' secondary generators. In bringing the subject forward, the committee thought that the first attempts which had successfully realised the distribution of electrical energy of varying potential, would be specially interesting to the members of the society, and, upon the invitation of our respected chief M. Tresca, Mr. Gaulard placed himself at the disposal of the meeting to furnish the most complete explanation of our apparatus.

"As you yourself were present at this first meeting, you would be able to appreciate the importance which the entire meeting attributed to the determination of the loss resulting from the transformation of energy by means of the secondary generators. The proofs produced by Mr. Gaulard at the meeting are worthy of examination, and we should fail in our duty as members of the Society if we did not encourage every enquiry that might enlighten our colleagues.

"We address ourselves to you, therefore, in the common interest which we have all agreed to support, as founders of the International Society of Electricians, whose future development will be maintained on a level with the general progress which it is intended to guide, and we request that you will name a day and hour when it will suit you to come to Edgware Road Station to verify the results obtained from the secondary generators, which are at work each day from half-past four p.m. to one o'clock a.m.

"Should you consider it desirable to bring with you Mr. Preece who is, as you know, a member of the English committee, we shall be extremely pleased to place ourselves entirely at your disposal.

"We are, Sir,
"Your most obedient servants,
"GAULARD.
"J. DIXON GIBBS."

"31, Golden Square,
"London, W., 21*st Feb.*, 1884.

"Gentlemen—In answer to your letter of the 18th inst., addressed to me as Honorary President for England of the Société Internationale des Electriciens, I beg to inform you that I have already declined a similar request, respecting another invention, addressed to me in the same capacity; and I can only reply to you in like manner, namely, that it is impossible for me to spare the time to investigate and verify details of electrical inventions unless brought to me to report upon professionally.

"When I remind you that during the last month 90 electrical inventions were patented, I think you will see that if I commenced to undertake or verify experiments as English President of the society, the honorary office might soon become excessively arduous.

"Moreover, in the case of your appliances, I think it would be better for you to arrange with some other electrician to take in hand any verification of results for you, inasmuch as about five and a half years ago I invented the system of distributing electricity by secondary generators which you employ.

"I refer you, hereupon, to my printed specification of October 22nd, 1878, No. 4212, for 'Lighting by Electricity,' from which the following is an extract:—

"'At each point where the electric light is used, the light or a group of lights is actuated by the secondary coil or coils of an induction apparatus fixed there.'

"'The primary coil of each induction apparatus is in circuit with a metallic main conductor, common to all, and connected with an electric battery or a magneto-electric machine which generates the current at any convenient locality.'

"'The size and length of the primary and secondary coils of the induction apparatus are adapted to the number of lights employed at each point where the secondary currents actuate the electric light.'

"I am, Gentlemen, yours faithfully,
"CHARLES T. BRIGHT.

"Messrs. Gaulard & Gibbs,
"The National Company for the Distribution of Electricity by Secondary Generators, Limited,
"18, Warwick Street, W."

The Metropolitan Brush Electric Light and Power Company, Limited.

Your issue of the 16th contained a long account of the above company's meeting on the 12th inst. I am desirous that every one interested in electric work should fully understand that the shareholders have been induced to withdraw from electric lighting through having, in my opinion, the facts as regards their Holborn work misrepresented to them.

The investigation committee have told the shareholders that the estimates for the Holborn work were rotten.

It will, perhaps, be sufficient evidence to the contrary that my estimates, prepared in the first instance with great care, were subsequently checked by tender and prices of well-known firms, such as Siemens Brothers, Hick Hargreaves, Johnson & Phillips, the India Rubber Company, &c., and that they were reported on to the largest original shareholder in the company, and the board, by Mr. R. E. Crompton, whose report, which is very lengthy, stated that both as to capital and revenue I had a very large margin; and, further, there were substantial men of business who had gone into the scheme who were prepared to find half the capital for the Holborn work, yet such was the state of mind that the shareholders had been put into by the committee that they would not listen to anything save a purely law policy.

This meeting listened whilst they were being told that provisional orders were worth nothing, and that the Holborn work could only result in loss, and that they had better sacrifice the whole of the money spent on provisional orders, and do nothing save put all their eggs in the one basket of law; and yet they would not even give a hearing to the biggest shareholder, who only became a member of the board because he was such, whilst he tried to explain how they could keep alive their work and make profit out of their provisional orders. Possibly, when the balance-sheet, showing all the results of the solely law policy and the money thrown away on parliamentary work comes to be considered, there may be a few regrets.

The point chiefly interesting to your readers is, that beyond any competent question, it is wrong to state that under proper arrangements the Holborn work would not have been profitable. Reliable opinion conclusively establishes the contrary. There is, and always must be, in every trade enterprise a certain uncertainty as to demand, but the facts as regards the number of lights to be obtained at Holborn were misrepresented to the shareholders.

Radcliffe Ward.

110, Cannon Street, E.C.,
Feb. 21st, 1884.

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